REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	2 Jun 00	Master's Thesis 6 Aug 99--2 Jun 00

4. TITLE AND SUBTITLE
THE AUSTRALIAN ~~ARTILLERY~~ INDIRECT FIREPOWER CAPABILITY: BRIDGING THE PARADIGM FROM INDUSTRIAL AGE TO INFORMATION AGE FIREPOWER

5. FUNDING NUMBERS

6. AUTHOR(S)

Major Philip R. Swinsburg

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Command and General Staff College
ATTN: ATZL-SWD-GD
1 Reynolds Ave.
Ft. Leavenworth, KS 66027-1352

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/ MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING

11. SUPPLEMENTARY NOTES

20001115 078

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE
Approved for public release; distribution is unlimited.	A

13. ABSTRACT (Maximum 200 words)
The present indirect firepower capability is influenced by its history and is still predominately industrial in nature. The adoption of an Army After Next concept will force the Australian Defense Force (ADF) to change from an equipment based defense force, to a capability based defense force. With the present indirect firepower capability still industrial in nature, emphasizing mass with dated effects management procedures and delivery systems, this will present particular challenges to the present capability in being in being able to transition to support the Army After Next (AAN) in the year 2020-2030.

This thesis describes the fundamental process that the Royal Australian Artillery must understand before the present capability can move forward. The concept of a 'systems of systems' is used to describe the components. This thesis discusses that the present force development process, based upon equipment replacement and not capability enhancement, combined with a cultural bias towards the delivery system, has prevented the present indirect firepower capability from developing. This thesis concludes that the ADF must develop a strategy linking the future indirect firepower capability to strategic guidance, national military strategies and future land warfare tasks, taking into account the indirect firepower capability as a system of systems.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Future Indirect Firepower Capability, Army After Next, Australian Defence Force,	160
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

THE AUSTRALIAN INDIRECT FIREPOWER CAPABILITY: BRIDGING THE PARADIGM FROM INDUSTRIAL AGE TO INFORMATION AGE FIREPOWER

A thesis presented to the faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE
Strategy

by

PHILIP R. SWINSBURG., MAJ, AUSTRALIAN ARMY
Bachelor of Professional Studies, University of New England, New South Wales,
Australia, 1998

Fort Leavenworth, Kansas
2000

MASTER OF MILITARY ART AND SCIENCE

THESIS APPROVAL PAGE

Name of candidate: MAJ Philip R. Swinsburg

Thesis Title: The Australian Indirect Firepower Capability: Bridging the Paradigm from Industrial Age to Information Age Firepower

Approved by:

_________________________________, Thesis Committee Chairman
LTC Charles J. Guerry, B.S.

_________________________________, Member
LTC Craig W. Orme, CSC, B.A.

_________________________________, Member
Harold S. Orenstein, Ph.D.

Accepted this 2d day of June 2000 by:

_________________________________, Director, Graduate Degree Programs
Philip J. Brookes, Ph.D.

ABSTRACT

THE AUSTRALIAN ARTILLERY INDIRECT FIREPOWER CAPABILITY: BRIDGING THE PARADIGM FROM INDUSTRIAL AGE TO INFORMATION AGE FIREPOWER, by Major Philip R. Swinsburg, 153 pages.

The present indirect firepower capability is influenced by its history and is still predominately industrial in nature. The adoption of an Army After Next concept will force the Australian Defense Force (ADF) to change from an equipment based defense force, to a capability based defense force. With the present indirect firepower capability still industrial in nature, emphasizing mass with dated effects management procedures and delivery systems, this will present particular challenges to the present capability in being in being able to transition to support the Army After Next (AAN) in the year 2020-2030.

This thesis describes the fundamental process that the Royal Australian Artillery must understand before the present capability can move forward. The concept of a 'systems of systems' is used to describe the components. This thesis discusses that the present force development process, based upon equipment replacement and not capability enhancement, combined with a cultural bias towards the delivery system, has prevented the present indirect firepower capability from developing. This thesis concludes that the ADF must develop a strategy linking the future indirect firepower capability to strategic guidance, national military strategies and future land warfare tasks, taking into account the indirect firepower capability as a system of systems.

CONTENTS

LIST OF FIGURES AND TABLES

ABBREVIATIONS

AAN	Army After Next
ABCA	American, British, Canadian, Australian
ADF	Australian Defence Force
AIB	Army in Being
BC	Battery Commander
BCSS	Battlefield Command Support System
C4I	Command Control Communications Computers Intelligence
C4ISTAR	Command Control Communications Computers Intelligence Surveillance Target Acquisition and Reconnaissance
COTS	Commercial Off The Shelf
DESS	Deciders, Effects, Sensors, Supporters
FLW	Future Land Warfare
FSU	Former Soviet Union
HE	High Explosive
HERA	High Explosive Rocket Assistance
ICM	Improved Conventional Munitions
IDF	Israeli Defence Force
ISTAR	Intelligence Surveillance Target Acquisition and Reconnaissance
JOSCC	Joint Offensive Support Coordination Centers
JOST	Joint Offensive Support Team
LOT	Life of Type
MLRS	Multiple Launch Rocket System

OF	Offensive Fire
RAA	Royal Australian Artillery
RISTA	Reconnaissance Intelligence Surveillance Target Acquisition
SP	Self Propelled
SR97	Strategic Review 1997
TA	Target Acquisition
TAB	Target Acquisition Battery
WP	Warsaw Pact

CHAPTER 1

AUSTRALIAN DEFENSE FORCE INDIRECT FIREPOWER AFTER NEXT

This thesis will attempt to answer the question of whether the present Australian Defence Force (ADF) indirect firepower capability[1] is adequate to support the Australian Army until 2010, and then help inform the capability development process of the Australian Army's Army After Next (AAN) capability concept.

Presently the Royal Australian Artillery indirect firepower delivery systems are not due for replacement until the year 2010, target acquisition systems are obsolete or approaching their life of type and little consideration has been afforded to the impact of supporting capabilities, such as meteorological and survey support. Additionally detailed analysis of future target types and effects has not been conducted to inform the future ammunition effects requirement. The result is a capability that lacks digitization, adequate range, and target acquisition capability within the region. Additionally the capability has a dated effects management process and does not have a strategy to address these deficiencies.

This thesis will discuss the significant impact which history has played on the present indirect firepower capability for the ADF and how the present capability is still strongly influenced by Industrial Age processes and technology. Recent capstone documents, such as *Land Warfare Doctrine 1: The Fundamentals of Land Warfare (LWD 1)* and *Future Land Warfare 2030 (FLW 2030)*, will be used to provide guidance on the type and nature of warfare in which the ADF expects to become involved in the future.

ADF Future Army Development Path

The ADF has embarked upon a journey to reshape the Australian Army to make it more credible and robust in the new post-Cold War geo-strategic and political climate. "The Army's concept-led approach is designed to optimize current capability by planning realistically for the future. The present force is referred to as the Army in Being (AIB) and is that force that exists at any point in time. The AIB is optimized through development paths for the next force, referred to as the Enhanced Combat Force; and the force after that referred to as the Army After Next (AAN). The Enhanced Combat Force is focused five to twenty years forward, and the AAN twenty to thirty years forward" (LWD1 1998, p1-7). The enhanced combat force is clearly defined in terms of capabilities, force structure, roles, and tasks but retains the flexibility to adapt to changing strategic circumstances (LWD1 1998, p1-7). This presents a force structure that is difficult to change over the next five to twenty years primarily due to the replacement of equipment platforms taking up to fifteen years and then those platforms remaining in service for up to forty years (FLW 2030 2000, 1:2). The equipment that the Australian Defense Force purchases in the next ten years will greatly influence the capabilities of the ECF and AAN due to this lengthy procurement process. A more responsive procurement and capability definition process will be required to support the AAN.

The intent is not to examine in detail the delivery platforms or ammunition systems which are often the focus for such capability questions, resulting in an equipment centric focus. Instead, this paper will look at whether the Royal Australian Artillery (RAA) capability as a "system of systems" will be sufficient to operate within the future environment as detailed by current strategic guidance,[2] *FLW 2030* and *LWD 1*. It will

investigate the strategy the RAA has adopted to support the notion of a "concept led and capability based" Army. This "concept led and capability based" Army is described in the most recent *Strategic Guidance 1997* (SR97), the *Fundamentals of Land Warfare Doctrine 1998 (LWD 1),* and the *Future Land Warfare documents 2000*[3] *(FLW 2030).* This thesis will examine the changing paradigm for the RAA from an industrial-to-information-based capability and discuss key changes in doctrine and organizational structure the RAA will need to consider to support the AAN.

It must be stressed that the RAA is only one component of a larger firepower system, that being the firepower system in the ADF. Firepower can come from any sources of energy and could be applied throughout the battlespace by ground, maritime, aerospace, space platforms, or a combination of these. The RAA currently provides the majority of indirect firepower to the land forces; whether this will continue to occur will depend on the versatility and adaptability of the RAA and how effective it is in supporting the AAN. This thesis will not discuss the role of infantry-based indirect fire weapons, such as mortars; however, aspects, such as mortars ammunition and performance characteristics, will be discussed as they relate to providing indirect close fire support to maneuver units in the AAN model.

Consideration of the capability of the RAA is required now because any new systems purchased in 2010[4] will be in service for at least twenty years, which is the standard life of type of tubed artillery delivery systems. This will, therefore, affect the capability of the AAN force. Also, the other components of the RAA capability, such as target acquisition, ammunition and support systems including logistics, will need to be considered before 2010, as most of these systems are approaching their life of type and

cannot be extended to 2010. These systems (effects, sensor, and support) will have an impact on the type and capability of the delivery systems currently considered for replacement around 2010 to 2015.

This thesis will emphasize the requirement for the force development process to view the future RAA indirect fire capability as a system of systems, not as individual components of a system, and how this system of systems will be affected by the emerging maneuver warfare doctrine of the ADF and strategic guidance.

While the replacement of the current RAA capability will occur before the AAN period of post 2020, this thesis will show that the consideration of capabilities for the AAN must occur within the Enhanced Combat Force (ECF) timeframe due to the follow-on effects for the AAN. Additionally, maximum use must be made of legacy systems to permit a cost effective use of available resources. Consideration of the replacement of one component of the total RAA capability will need to take into account the entire future RAA capability, which will affect ECF and AAN capabilities. For example current target acquisition systems consist of two elements, one active and one passive. The passive system is now obsolete and the active system has a life of type of 2002.[5] The replacement of these systems will need to be informed by the future RAA delivery system, due for replacement in 2010 to 2015, to ensure these systems are compatible and have stretch[6] potential for the future.

There is an ongoing study within the ADF that is looking at the aspects of firepower.[7] This study, while informative will not be able to address the RAA capability in the detailed required. This thesis will help to fill that gap.

This thesis will not discus in detail the impact that airpower or maritime forces will have on how the RAA will support the AAN concept. While they are vital components of joint firepower, they are beyond the scope of this document. The aspects of training and facilities that form a component in the definition of capability will not be discussed.

The RAA consists of two main branches of Artillery: the Field branches, consisting of Tube Artillery and Target Acquisition (TA) Artillery, and Air Defense Artillery. This thesis will not discuss the aspect of the Air Defense component, but will limit its research and analysis to the Field Artillery.

Assumptions

The assumptions which will be used throughout the development of this thesis are:

1. The projected replacement of the RAA current delivery systems will occur around 2010-15.

2. The contract with Australian Defense Industries (ADI) to provide 105-millimeter HE M1 ammunition will remain extant until at least 2010.

3. The present ammunition system for the 105-millimeter and 155-millimeter delivery systems does not change until 2010.

4. The Battlefield Command Support Systems will be introduced but will not be provided down to the platform level before 2005.

Thesis Structure

This thesis is structured in eight chapters. Chapter 1 lays the foundation and guidelines for the remainder of the thesis, identifying key terms and limiting the scope of

the thesis. Chapter 2 explores how previous defense policies have impacted upon the RAA capability through the unique Australian military strategy adopted from the 1980s until 1997. It describes how the strategic policy during the 1980s and early 1990s, focusing upon the defense of Australia, limited the application of advancement in technology which other countries were applying. It discusses how the previous insular defense policies and negligible threat scenarios maintained a level of technological isolation within the Army, which influences the AIB. The chapter explores the definition of Industrial and Information Age firepower and describes the "system of systems"; which comprises the RAA.

Chapter 3 describes how history has molded the present force structure and capability in the RAA. This chapter looks at the lessons which emerge from World War One and the Yom Kippur War in 1973, highlighting trends which both the West and Former Soviet Union adopted to enhance their firepower capabilities. These two eras were chosen as they had the greatest influence on the development of technical aspects of indirect fire capability. World War One provided the dawn of the indirect firepower capability in modern time, which would see little modifications in techniques until after World War Two. The Yom Kippur War in 1973 was the catalyst for Western armies to review their notion of modern warfare, based upon a Soviet threat. The absence of this Cold War Soviet threat reduced the significance of this campaign for the ADF, reflected by similar ammunition and techniques employed from 1950s until today. This chapter also describes some of the constraints that will influence the future RAA capability.

Chapter 4 describes the present status of the RAA capability and breaks the RAA capability into four systems for detailed analysis. This chapter highlights the deficiency

in doctrine which exists for the introduction of new surveillance and target acquisition systems, as well as the requirement to review the future artillery requirement well before the 2010 timeframe, due to other systems within the RAA capability requiring replacement prior to this time. This chapter describes the trends in ammunition development which have occurred throughout the world, but have not been adopted by the RAA, due to strong historical influence of existing systems and present training emphasis.

Chapter 5 discusses areas, such as the future threat environment and the characteristics, required of the RAA capability to support a maneuverist approach to future warfare. The chapter concludes that the present organizational structure of the RAA is too rigid and inhibits the application of all systems within the RAA capability, except for warfighting tasks. The preclusion of the RAA from military support operations will inhibit the RAA's ability to support the AAN. A tailorable force packaging approach will have to be adopted by the RAA to better support AAN concepts.

Chapter 6 is a comparison of the United Kingdom's, United States' and Australia's future land warfare doctrine. This chapter highlights the similarities in the approach taken by all three countries and describes the importance of Australia's maintaining parity with these countries to ensure that the RAA can make a worthwhile contribution to coalition operations.

Chapter 7 looks at emerging trends occurring throughout the systems within the RAA capability. This chapter highlights that weapon systems are reaching longer ranges and will significantly overmatch the RAA capability until 2010. These trends are likely to continue, emphasizing the need to review the RAA capability before the 2010

timeframe to ensure that the ADF and the RAA maintain regional parity or overmatch in indirect fire capability.

Chapter 8 summarizes what has been presented. It provides some suggestions and recommendations for the way ahead for the future indirect firepower capability.

---

[1]Capability is the combination of force structure and its preparedness, and encompasses equipment, trained personnel to operate that equipment, facilities, and the total supportability of the systems to be able to operate effectively and efficiently.

[2]Strategic Review 1997

[3]A new Strategic review is currently being conducted and is expected to be released in 2000. It is believed that the Strategic Review 2000, will continue to emphasis these concept and build upon them for the AAN.

[4]This date is predicated on the current expectation that both the 105-millimeter L119 and the 155-millimeter M198 systems will be replaced on or about this time-period.

[5]Presently there is no plan to upgrade or renew this capability. The ability to extend this Life of Type (LOT) to 2005 has been discussed but at Jan 2000 no decision to extend this LOT has been made. Spare parts exist to be able to extend this to 2005, but after that time-period the reliability of the system due to the age of the components may impact on the operational viability of the system.

[6]Stretch potential is considered the ability for a system to undergo a progressive upgrade program without the need to replace the entire system.

[7]Conducted by Land Development Branch Capability Systems Division, Australian Defence Headquarters.

CHAPTER 2

INDUSTRIAL AGE FIREPOWER--HISTORY AND LEGACY

Chapter 2 lays the foundation of where the RAA currently exists across all components of indirect firepower capability, highlighting the importance that history has played in the development of that capability to date. The chapter commences with a brief historical introduction from 1600 until the Yom Kippur War in 1973, as these milestones have had an important impact in the development and employment of the artillery capability throughout the world. The historical passages describe how artillery has emphasized massing delivery systems in order to mass effects. This was due to the inherent inaccuracy of the delivery systems and the poor observation and acquisition systems in place. Technology has permitted a shift in recent years away from the massing of weapons to the centralized management of effects.

In order for the RAA to support the AAN, it is important it is understood how history has shaped the development of the RAA capability. This, combined with where emerging concepts and doctrine indicate were the capability needs to be headed, will help generate a more complete picture.

Historical Trends for Field Artillery

From the seventeenth century until the commencement of World War 1 the primary function for field artillery had been as direct fire support weapons formed with or close by the assaulting infantry. Artillery ranges were limited to 1,500 to 2,500 meters with the focus being on supporting the close battle.[1]

The firepower of the guns in the seventeenth and eighteenth centuries was relatively limited, and to achieve the desired effect the guns had to be massed together to ensure that they fired as one unit and landed in the same vicinity of the target. Throughout this time, the artillery was seen as an extension of the infantry and incorporated direct fire techniques.

Napoleon understood artillery capability especially against unprotected infantry. What is noteworthy is that Napoleon identified a decisive point[2] and used his artillery along with his combined arms of cavalry and infantry at the decisive point to bring about the destruction of the enemy (Bailey 1989, 115). He determined the effect he was after and set about to achieve it with his artillery, cavalry, and infantry.

Napoleon also understood the requirements for effective command and control of artillery and for its being used independently of the infantry assault. At the Battle of Friedland (1807) control of the artillery was decentralized and provided continuous covering fire of the assaulting infantry to within 120 meters of the Russian positions. This operation was an example of the creeping barrage, which was to be repeated in World War 1, and provided a clear example of how artillery could be employed as a tactical unit separate from the infantry (Bailey 1989, 115).

Improvements in infantry weapons in the 1860s, due in part to the Industrial Revolution, the development of rifled barrels, and the cylindro-conoidal bullet, gave the infantry the ability to engage the artillery, which had previously been deployed too far away from the enemy infantry range. This caused the artillery to drastically review its tactics when in direct support of infantry and altered how it would support the infantry.

The indirect method of fire was developed in an effort to reduce the casualties the artillery was now suffering from improved infantry weapons. The indirect fire method had been developed as early as the 1750s but was not widely adopted until the nineteenth century (Bailey 1989, 118). This method of fire was only slowly accepted by the infantry, as it significantly increased the time taken to register and fire onto targets. Coordination was difficult as the observer had to position himself between the firing unit and the target, and the means of communication at that time were voice or landline. Importantly though there was a view that the artillery had to face the enemy beside the infantry. This was as much a social issue as anything else, and lingers in most Western armies, where artillery remains a "supporting" arm of the infantry (Fort Sill ammunition handout, part 1).

As artillery began to exert its influence on the World War 1 battlefields, counterbattery fire grew in significance. This developed into a specialized area and forced the artillery to view the battlefield in two dimensions: close support and the deep battle. This had follow-on implications in the development of target acquisition systems and the requirement for improved accuracy in survey and meteorology, as the range of the systems increased to now engage targets in depth. The introduction of airpower towards the end of World War 1 and in World War 2 presented a third dimension to the application of firepower.

The lessons learned from 1700 until the end of World War 1 shaped the development of modern artillery doctrine, most of which is still evident in current RAA doctrine. In *Field Artillery and Firepower*, J. B. Bailey summarizes the lessons from this

era and provides a treatise of artillery development over the ages (1989, 128). The main points from the early development of artillery are:

1. In order for firepower to be effective in the close battle, it needs to be mobile, with very effective command and control systems in place.

2. The deep battle needs to be decisive in order to maintain an asymmetrical advantage in firepower in the close battle. This requires targets to be acquired and engaged at ranges where they cannot influence the close battle.

3. Logistics for artillery in World War 1 and afterwards, including World War 2, Korea, and Vietnam *(and the Gulf war 1990-91)*[3], were essential to successful mission completion. Logistics will pose a significant burden on the artillery systems of the future if similar quantities of ammunition are to be used again.

4. The importance of support systems for artillery, such as survey and meteorology, will increase in importance as mobility, dispersion, and range increase.

5. Due to the limited range and lethality of the ammunition leading up to World War 1 the requirement was to mass weapons to achieve a mass effect on the target. Organizations and doctrine emerged from this based around the six-gun battery, incorporating three batteries into a regiment for ease of command and control. The lesson to be learned is massing effects and not delivery systems at the decisive point (as Napoleon achieved) is required.

6. Artillery capability is a system comprising a number of interrelated systems summarized as the controlling element, the effects element, the sensors required to acquire targets for engagement, and the supporting elements.

Israeli Experience with Artillery and Its Impact upon Equipment Development.

The experience of the Israeli Defense Force (IDF) from 1967 to the Yom Kippur War in 1973 had a profound effect upon Western and former Soviet Union (FSU) artillery doctrine. The US and other Western powers had believed that any conventional warfare against the FSU would be a protracted operation conducted over a number of months in Europe. The Yom Kippur War provided an insight into a highly mobile and short-duration war between two forces that, in fact, represented a Western-equipped and trained force (the Israelis) and a Soviet-equipped and trained force (the Egyptians and Syrians).

Before the 1967 Arab-Israeli War, Israeli artillery was poorly equipped to support the way the IDF wanted to fight, that is on a highly mobile armored battlefield. The IDF had only one self-propelled artillery brigade, with the remainder of the force using towed 105 millimeter and 155 millimeter weapons that remained stationary after the initial opening barrage (Bailey 1989, 252). The IDF increasingly relied upon airpower to carry out the traditional fire support tasks of Israeli artillery, resulting in little emphasis being placed upon doctrinal or equipment improvement between 1967 and 1973.

This is similar to the Australian Strategic Guidance issued in 1987 and 1994, whereby the maritime approaches would be dominated by air and naval forces. Any forces which were successful in landing would be of such an insignificant size that only small amounts of land combat power would be needed to deal with the situation. This reliance on air and naval superiority in the northern approaches to Australia was reduced by the inference in *Strategic Review 1997*, as well as the *Future Land Warfare 2030*

document and the *Joint Standing Committee on Foreign Affairs, Defense and Trade* (JSCFADT), whereby the land forces will become engaged in areas to the north of Australia, offshore, and in the littoral environment (JSCDFAT Executive Summary 1999, section 1). This highlights that Australia may not be able to enjoy any form of air or naval superiority if involved in operations within the region and that hostile forces encountered by land forces are likely to be more numerous than those presently anticipated.

During the 1973 Yom Kippur War, the IDF assumed that air superiority would be achieved, "which lessened the importance of artillery even more" (Bailey 1989, 253). The difference in the 1973 Yom Kippur War was that "the air defense systems in the Middle East were 20 times denser than those in the Warsaw Pact (WP) countries of the time" (Bailey 1989, 253). This highlighted the importance of artillery and the increased use of antitank-guided missiles, and made unsupported armored operations a very costly experience. The IDF quickly realized that artillery and large caliber 155 millimeter artillery, centrally commanded and controlled, were required to halt Arab armor formations. This led to increased emphasis on combined arms operations and sparked the emergence of the US AirLand Battle doctrine, which was heavily influenced by the lessons learned from this conflict.

The comparison between the Yom Kippur War and the ADF application of indirect firepower may not be easily understood. The IDF relied upon airpower as the primary means to attrit Egyptian forces as they moved across the large open expanse of the Sinai desert. The Egyptian employment of the SA-2 surface-to-air missile negated this capability, preventing the Israeli airforce from supporting the ground forces, resulting

in a highly successful attack. The present maritime strategy for the sea-air gap in the north of Australia relies heavily upon the attritional effect by airforce and naval assets prior to an enemy lodgment on Australia. Any change in strategic guidance by Australia into a more littoral environment will see a reduction in the size of the sea-air gap and an increased reliance on the part of land forces upon integral fire support systems. The IDF used the Sinai Desert as their version of the sea-air gap (sea of sand) to achieve the 48 hours required for the mobilization of the reserves, relying upon air power as they had in the 1967 War. The asymmetrical threat presented by the Egyptians and their air defense coverage can also be achieved in Asia, where the integrated air defense capability of most nations far exceeds the capability of the ADF.[4]

The after-action review of this war was also the genesis of research and development into artillery delivered precision-guided munitions, such as Copperhead, and improved conventional munitions, such as bomblet rounds. The ADF did not review the outcome of the 1973 war as closely as other countries did. The result was that the ADF did not investigate the utility of precision-guided munitions or improved conventional munitions, maintaining to this day the requirement for conventional point detonating high-explosive ammunition. The 1991 Gulf War was the result of the changes the US military made as a result of the 1973 war.

When the Yom Kippur War ended, the "total tank and artillery losses for both sides together exceeded the entire tank and artillery inventory for the U.S. Army, Europe" (Leavenworth paper No.16, 1988, 30). The Yom Kippur War provided good insight into modern tactics and equipment, especially for the West and the FSU, as they believed this was how their next major confrontation would be fought. The lessons from this

campaign forced the Israelis to rely upon combined arms to achieve victory and would affect the development of equipment and doctrine throughout both the West and FSU. Some of these lessons were:

1. The West saw the importance of robust Command and Control systems for the control of artillery fire to allow them to mass onto high payoff targets (Bailey 1989, 254).

2. The FSU countries saw the advantage in highly mobile self-propelled (SP) artillery, as well as reinforcing the benefits of rocket artillery learned during World War 2, in order to provide an intense heavy weight of fire with a large shock effect (Bailey 1989, 254).

These effects can be seen today with the West's adoption of various C2 systems and the continued push for digitization, which was again enhanced by the experiences in the 1991 Gulf War. The West in the past twenty years has improved its SP artillery capability, but initially as a counter to the development of the FSU 2S1 and 2S3 model self-propelled artillery systems. The FSU enhanced its SP artillery capability and continued to develop a comprehensive multiple-rocket systems capability based upon the BM21, and in recent years the 220 millimeter BM-22 URAGAN and the 300 millimeter BM-30 SMERCH. The US Multi-Launched Rocket Systems (MLRS) was developed to counter the disproportionate advantage the FSU had in artillery and tanks. The MLRS has evolved into a more specialized anti-armor and anti-materiel system dedicated to the deep battle in an attempt to attain an asymmetrical advantage in US artillery.

History has shown that artillery has traditionally emphasized mass to achieve the effects it requires. This massing of forces was due principally to the desired nature of the effects at the target. Imprecise and inaccurate ammunition determined the requirement to

mass large quantities of delivery systems and ammunition to achieve the desired effect. A lack of independent communications between individual delivery systems, as well as a centralized ballistic computation process, forced units to physically mass to facilitate the effects.

Artillery is an area weapon, but with improved ammunition systems, better command, control, communications, computers, intelligence (C4I), and digitization down to the delivery systems, and the move into precision, this paradigm of massing weapons to achieve a massed effect is no longer acceptable. Massed forces are more susceptible to air attack and more costly to procure and sustain and do not make the best use of emerging advances in technology in C4I, Surveillance, Target Acquisition and Reconnaissance (C4ISTAR) systems.

Summary

This chapter has shown the historical influences that have shaped modern artillery capabilities throughout both Western and FSU countries. However, Australia's strategic guidance has been geographically "Australian Centric" for the past twenty eight years. This has resulted in a biased interpretation of the technological advancements that have been made in the areas of precision, digitization, and communications. The ADF has understood the requirements for such capabilities, but due to the limitations of strategic guidance, especially in 1987 and 1994, has had to be content with a minimal threat environment. This, combined with regional influences over the past forty years in Malaysia, Indonesia, and Vietnam, fighting relatively unsophisticated and decentralized operations, has further delayed the analysis of the application of high-tempo operations, emphasizing digitization and precision systems, and massing effects over massing forces.

The AAN, as described in *FLW 2030*, indicates that the ADF will need to move out of the industrial age and into the information age, which will characterize future operations.

The low-scale conflicts of the past and the lack of technological innovation have enabled capability development to take a piecemeal approach. The result has been that the ADF's indirect firepower capability consists of the necessary subsystems required for the capability, but without an overarching strategy for the adoption of new technology or insight into how that technology will impact the entire capability. The RAA must adopt a system of systems approach to enable it to move into the information age.

The 1973 Yom Kippur War was a watershed in the area of precision and doctrinal development for the western countries that were involved against a Soviet threat prior to the end of the Cold War. The result was a technological and doctrinal evolution that resulted in the development of digitization, cannon-launched guided munitions and improved conventional munitions, along with integrated target acquisition vehicles for observers and a high priority placed upon target acquisition radars. This technological development has continued unabated to the present day. While the 1973 war could be viewed in isolation as not applicable to the Australian strategic guidance, it nevertheless provided a rare glimpse of the future nature of warfare. The ADF indirect firepower capability must determine what future effects will be required and tailor the capability towards that analysis.

---

[1]Artillery assists other arms by engaging targets within their immediate vicinity, provided they are within range of the systems. Artillery employs close fire support to engage enemy troops, weapons, or positions, which, because of their proximity friendly troops, present an immediate and serious threat to the supported arms. Its aim is to neutralize or destroy enemy infantry and armor, including organic support weapons such as mortars, which can directly interfere with our operations. Such engagements

constitute the "close battle". It involves close offensive and defensive fire planning. MLW 2.1.1 Employment of Artillery, p13.888.

[2]A decisive point is a major event that is a precondition to the successful disruption or negation of the center of gravity of either combatant. A decisive point is created normally by successfully attacking or neutralizing a critical vulnerability. Operational level planning aims to exploit an enemy's critical vulnerabilities in a sequence or matrix of decisive points known as lines of operation. (Australian Warfighting Concepts to Guide Campaign Planning-Decisive Maneuver, interim edition, January 1998)

[3]Authors emphasis.

[4]The low level air defense of the ADF is limited to one Air Defense unit equipped with Rapier B1 missile and the manportable RBS-70. No medium to high level AD capability exists outside the conduct of Defensive Counter Air operations of the Australian Airforce.

CHAPTER 3

STATUS OF PRESENT CAPABILITY

This chapter will provide an assessment of the present status of the RAA's capability. This assessment will use the areas of Deciders, Effects, Sensors, and Shooters (DESS) to define the capability in system components. This chapter will identify strengths and weaknesses of the present systems. This will assist in analyzing future developments to identify those areas requiring modification to permit the smooth transition to the AAN. Ensuing chapters will look at future RAA requirements to support the AAN and compare development in ABCA countries to that of Australia to evaluate the RAA's ability to support coalitions.

Deciders.

For the purpose of this thesis, "deciders" refer to any automated systems which aid in the decision-making process by informing a person empowered to make an appropriate decision regarding the most effective employment of a response capability. When discussing a response, it should be highlighted that all types of response systems, both lethal and nonlethal, must be included. Using this definition, the RAA presently does not have any decider systems currently in service.

Command and Control

The RAA command elements known as the Joint Offensive Support Coordination Centers (JOSCC) are located at all levels of command above company. This group is responsible for the command of the artillery unit allocated to the supported unit, as well as the coordination of all lethal and some nonlethal response systems in that unit. Current

procedures in the JOSCC rely upon voice transmission internal to the headquarters and external to the respective responding units. No dedicated communications exist with non-artillery units that may need to effect a response. All responses which involve units not under JOSCC command (artillery units only) require the formation operations staff's approval. This hierarchical approach to control is characteristic of Industrial Age firepower.

To streamline this approval process and coordinate the integration of all lethal and nonlethal fires, the Joint Targeting Board (JTB) convenes at both the brigade and joint task force level to determine the most appropriate effect required on either planned or opportunity targets. This process streamlines the response and tasking times of subordinate units. Currently, apart from direct communications to the Joint Offensive Support Teams located with one team to each maneuver company[1], no communications exist between any sensors into the JOSCC, resulting in costly time delays for relaying information and locations. This is overcome, in part, by the collocation of critical sensors, such as the target acquisition battery (TAB) elements, located next to the JOSCC in the respective headquarters at brigade or task force and above. When no TAB units are deployed on operations, this communication link does not exist.

A trial conducted by the ADF over the 1995 to 1997 period saw the formation of the Reconnaissance Intelligence Surveillance and Target Acquisition (RISTA) Regiment. The intent of this trial was to propose an organization solution to a procedural challenge the ADF had been facing for many years. The challenge was how to best organize and manage the wide number of disparate sensors available to tactical formations, control their information management, and provide a value added product to the commander in a

timely fashion. The reason for this trial was the poor performance of information management regarding ISTAR[2] systems during the ADF's major exercises, Kangaroo 92 and Kangaroo 95, held in 1992 and 1995, respectively.

The RISTA trial resulted in the 1st Intelligence Company and the 131st Target Acquisition Battery combining to provide the nucleus of a regimental-size unit. Other elements were added as required during exercises, such as electronic warfare assets and unmanned aerial vehicles, with direct access to systems, such as the Defense Science and Technology Organization's Synthetic Aperture Radar. All of these sensors, including the TAB AN/TPQ 36 weapon locating radar, RASIT 3-B ground surveillance radars, and AN/TAS 6A thermal surveillance systems, were managed to provide the commander a coherent picture of the battlefield.

The RISTA trial, while designated a success,[3] was overcome by a much stronger diametrically opposed hypothesis, the Army 21 trials, which saw the requirement for imbedding assets down to the lowest possible formation in which they would be used. The result was the disbanding of the RISTA regiment and a disbursement of the sensor systems available in the unit, as well as a large portion of its personnel, throughout the ADF for the duration of the Army 21 trials. The outcome of the Army 21 trials has reinforced the results of the RISTA trial through the recognition that specialist sensors and skills are best managed in a centralized fashion, but having the equipment decentralized down to the lowest usable level. This provided the integration of information at all levels and utilized the scarce sensors most efficiently. Both trials concluded that a coordinated effects management process, focusing on results and not the command of the individual platforms, offered the best chance of success. Since the

RISTA and the Army 21 trials, the ADF has moved forward and is now unable to reform the RISTA regiment. The 131st TAB has been reformed to its pre-RISTA formation.

This area of staff integration and focus upon the wider response systems available to the ADF, not just indirect firepower, will provide the most significant capability enhancement to the ADF and truly complement the knowledge edge. This is an area which needs to be developed by the future indirect firepower capability, especially in the area of doctrine development and integrated C4I systems.

Ballistics Command Post Calculations

One of the significant differences between industrial age and information age firepower capability is the way the system computes and distributes the firing solution for targets. Industrial age systems will rely on a centralized ballistic computation process, normally in a local command post, passing information individually to each delivery platform. Information age firepower will rely upon a decentralized computation capability with individual delivery systems having the ability to receive tasking directly from any number of observers and individually compute firing solutions.

The RAA gunnery computer conducts the current form of ballistic computation. The gunnery computer is a commercial off-the-shelf (COTS) system utilizing unsophisticated computation programs to compute firing solutions for weapons systems[4] originally designed for a less capable computer. No automatic or semiautonomous link is presently available to connect this system to a radio or other indirect fire capability components. The lack of this link and the current scale of issue, as well as the maintenance of a centralized command post per battery for computations (MLW 2.1.1,

1995, p11.814.d), will continue to prevent the RAA from emphasizing anything apart from massing delivery systems to achieve a massed effect.

The ADF is working on a decider system under the broader Battlefield Command Support System (BCSS) capability. The BCSS is designed to provide an office automation package that includes a number of sub-system components. Currently the system includes areas for intelligence and maneuver, such as digital mapping and staff planning tools. The BCSS offensive fires (OF) sub-system intends to provide sensor to shooter integration options, ballistic computation options, and a BCSS offensive fire future options plan. The aim of BCSS (OF) is to assist commanders to control and coordinate offensive fires.

This system makes maximum use of COTS components, but will not be able to fully integrate all of the available sensors on the battlefield to the existing C2 structure.[5] The in-service date for this project is projected for March 2000, but because of the present deployment of forces to East Timor, the trialing and fielding of such a system is likely to be delayed. In addition, unless the BCSS systems is distributed to the individual platform level, the ability to disperse delivery and sensor systems will be limited and will maintain the notion of massed weapon systems, retarding the development of innovative ways to support the AAN.[6]

Joint Offensive Supports Teams

Joint offensive supports teams (JOSTs) are normally deployed with the supporting maneuver units and control the effects of indirect artillery fire and close air support. JOSTs are currently limited to operating their equipment dismounted due to the lack of a dedicated armored or wheeled integrated observation vehicles. This requires all

equipment to be carried by the individual observer, except when relying upon visual observation and engagement. This lack of an integrated observation vehicle reduces the quantity and size of any decider or target acquisition systems that can be incorporated with the JOST.

Where armored or soft skinned vehicles are provided, they are used primarily as a means of transport and not as an integrated observation and command vehicle. JOSTs and battery commanders (BCs) are also responsible for the coordination of not only indirect artillery fire but also all air and naval offensive fires means. Additionally, they will integrate any organic infantry direct or indirect fire systems available to the maneuver unit. All these procedures are currently completed using manual methods, with control being exercised over the radio by voice, and not aided by any decision systems.

Summary

The introduction of the BCSS systems into the RAA will only be truly effective and revolutionize the way the RAA conducts warfighting if the BCSS terminal is decentralized down to the individual delivery and sensor platforms, and incorporates sensors and shooters outside the traditional RAA hierarchy. This will permit a marked increase in operational tempo, not just the automation of the present formats and protocols. A system that truly embraces the functionality of network-centric warfare, as discussed in LWD 1, is needed for the future indirect firepower capability to move into the information age.

Effects

The effects component of the capability is divided into two areas: the artillery weapon, i.e., the ammunition, and the delivery system.

Ammunition Systems

The ammunition systems used in the RAA for the 155-millimeter M198 and the 105-millimeter L119 are the 155-millimeter M107 and the 105-millimeter M1 ammunition. Other ammunition systems include the L15 and the High Explosive Rocket Assist (HERA) projectile (MLW 2.1.2, 1988, figure 6-12). The RAA primarily uses the M107 and M1 ammunition systems with the inclusion of nonstandard ammunition, such as illumination, smoke base ejection, and white phosphorous.

When discussing ammunition it is important to examine the type of fuses used to initiate the ammunition. The RAA has relied and continues to rely upon the point-detonating fuse. This is the same fuse that was used so successfully in World War 1 to turn the fields of the Somme into a muddy quagmire. The point detonating fuse initiates the explosive train on impact with the ground, resulting in the shell bursting open and spraying metal fragments near the projectile. The intent is to indiscriminately engage personnel and material within a given area.

When a high explosive (HE) projectile explodes it projects fragments at right angles to the longitudinal axis of the ammunition and forward due to the momentum of the projectile. Therefore, unless the angle of descent is very steep more than one half of the fragments go into the ground or skyward, eventually falling with little energy, and are therefore wasted. Additionally, after the first 15 seconds of engaging a position the enemy has most likely sought shelter in his pits or armored vehicles, or is lying close to the ground, so that the ammunition's destructive effect has been reduced significantly.[7]

To overcome this reduced effectiveness, artillery in the past has continued to fire large amounts of ammunition onto an objective in the hope that the enemy would be

neutralized and prevented from engaging friendly troops. This also has the effect of slowly increasing enemy casualties. The result is that a large quantity of ammunition is needed to support the infantry. A comparison between an Australian field artillery regiment and a US field artillery battalion indicates the tendency for the RAA to dwell in the past concerning ammunition. An average RAA field regiment carries 102 rounds per gun of HE ammunition, compared to a US battalion carrying only 28 rounds.[8] The remainder of the US ammunition consists of improved conventional munitions and specialized ammunition systems. A detailed breakup of a US Field Artillery battalion is shown at table 1.

Table 1: M109A6 Field Artillery Battalion Ammunition

Projectile Nomenclature	**Projectile Type**	**Quantity**	**Remarks**
M731	ADAMS	48	Artillery Delivered Area Denial Mine System
M484	ILA	36	Illumination
M741	RAAAMS	216	Remotely Activated Artillery Area Mine System
M712	COPPERHEAD	90	Precision Guided Munition
M825	SMOKE	220	
M107	HE	504	High Explosive
M110	WP	36	White Phosphorus Smoke
M483	DPICM	2916	
M549	RAP / HERA	424	Rocket Assisted Projectile
M864	BBDPICM	1144	Base Bleed DPICM
	TOTAL	5544	
	TOTAL HE	504	Assuming all M549 is HE and Not DPICM
	TOTAL DPICM	4484	Includes RAP/HERA

Source: Fort Irwin Homepage www.irwin.army.mil/wolves/class_v_ubl.htm accessed 28 December 1999.

Trends first developed in World War 2 saw the Western powers adopting airburst ammunition, replacing point-detonating fuses with ones that detonated the projectile at the optimum height (ten to twenty meters above the ground). The fuses were of two types: those using radio reflections, called proximity fuses, and those using a mechanical time fuse.

Due to the cost, following World War 2 proximity fuses only made up a small percentage of the overall fuse types. Also the requirement to adjust the height of burst for mechanical time fuses and adjust this every few hours due to meteorological corrections saw these fuses reduce in importance in the period between World War 2 and the Vietnam conflict. During the Vietnam conflict, proximity fuses were rarely used due to the requirement to penetrate the jungle canopy.

The nature of warfare has changed significantly since the Vietnam War and is expected to change even more in the future. The RAA has not modified to any significant degree the ratio of point detonating fuses to airburst fuses or reviewed the type and quantity of ammunition needed to be deployed with each gun. The RAA has maintained similar standards and quantity of ammunition as those recommended by the US field artillery in 1914: 106 rounds per three-inch gun (Thummel, 1914, 77). The United Kingdom (UK) subsequently adopted a similar standard as a result of the report, and it is from the UK that Australia also adopted its standards.

A study of the armament and types of artillery material to be assigned to a field army, conducted on order of the US Secretary of War in 1919 by the Office of the US General Chiefs of Staff, then General Peyton. C. March, concluded that a 105-millimeter howitzer with a projectile of thirty to thirty pounds would be the ideal field artillery

weapon. A carriage interchangeable with the 75-millimeter French Model 1897 and the US Model 1916 was used for the 105-millimeter systems, resulting in the same ammunition carriage being used. Thus, the ammunition figures determined in 1914 were used for the 105-millimeter systems after World War 1 (*US Field Artillery Journal* 1919, 309).

This reinforces the significance of the 1973 Yom Kippur War as a watershed in doctrinal and equipment development, especially regarding ammunition systems. Australia's strategic guidance reduced the significance of this operation, resulting in the maintenance of pre-World War 2 standards for artillery while the UK and US moved forward. These figures, combined with the type of ammunition, maintained the notion of the requirement for mass, and maintained a high logistical burden, due to inefficient fuse selection and ammunition type. This is not to say that airbust fuses will be needed in the future, but it does highlight the lack of intellectual development that has occurred in the area of ammunition selection and challenges future indirect firepower capability to seek a more effective way to conduct its mission. The UK Army's standard projectile is the L15 ammunition system utilizing the multirole fuse. The standard mission for UK artillery is for the fuse to function at a height of burst of nine meters above the ground. Should the fuse fail to function, a backup point detonating fuse will function. The point-detonating function can also be manually selected if the mission requires. The fuse can also be set to delay to engage targets that are slightly below the surface, such as dug-in troops with overhead protection. This multirole fuse further reduces the logistical burden of the systems through the reduction of fuse types.

The requirement to increase the effectiveness of HE projectiles resulted in the introduction of improved conventional munitions (ICM). The US developed the first ICM rounds, and during the 1980s and 1990s they quickly became the weapon of choice for most NATO countries against the massed Soviet threat.

Compared to the standard HE projectile, the ICM projectile increased lethality and effectiveness. The HE content of the projectile was replaced with smaller bomblets carried inside the projectile and jettisoned over the top of the target area. This increased the vertical angle of descent and ensured a wider coverage over the same area, increasing the level of effectiveness in the first fifteen seconds of impact. The bomblets were designed for both antimaterial and antipersonnel capability, hence the term "Dual Purpose ICM" or DPICM.

Bomblets vary in size and quantity, ranging from 18 in a 105-millimeter shell to 644 in the M77 MLRS rocket. Each bomblet is equivalent in size to a 40 millimeter grenade and includes a shaped warhead for the antimaterial aspect and a perforated liner for the antipersonnel effect. The use of DPICM has significantly increased the effectiveness of the projectile and is able to reduce the quantity of rounds employed on each target to achieve the same effect.

The problem with DPICM rounds is that the accuracy and discrimination of the projectile were not improved, and an initial 5 percent failure rate for the bomblets significantly increased the risk of fratricide (*Fort Sill Ammunition Handout*, 1995, 4). This is only a consideration, however, if land forces intend to move through the area. Nevertheless, more attention will be paid to the employment of these systems in the future, due to the potential for collateral damage, namely civilian casualties. Civilian

casualties can arise even if the military decides not to move through the area. An improved self-destruct mechanism has now reduced this failure rate to approximately 1 percent; however, the decision to use DPICM, especially in urban operations or military support operations, will need to consider the impact upon the civilian population.

Table 1 shows the standard unit basic load for a M109A6 Paladin Battalion.[9] The table indicates that only 23 percent of the battalion ammunition is conventional HE, with the remainder being DPICM.[10] Additionally each delivery system is also supplied with two Copperhead cannon launched precision guided munitions (CLGM), as well as two or three rounds each of both the M731 area denial artillery mine system and the M741 remotely activated artillery area mine system. This provides the US artillery and maneuver commander with a great deal of flexibility and choice over what type of effect can be achieved. The table is not meant to show what ammunition systems the RAA should pursue, but simply illustrates the trend away from conventional HE as the weapon of choice, and toward more flexibility for the commander regarding employment of the artillery capability.

The ADF has been slow to adopt any variation in its ammunition types. It is questionable if any improved capability can be afforded by the incorporation of only DPICM rounds into the RAA indirect fire capability. The DPICM projectile is more efficient but the systems will not be any more accurate or able to achieve a decidedly different effect. A capability enhancement may be realized in the reduced ammunition expenditure due to the reduced quantity of projectiles needed, and therefore a smaller logistics requirement. A true capability enhancement would be achieved by a

combination of new projectiles incorporating some kind of enhanced accuracy and precision capability through an improved fuse mechanism.

In 1995 the ADF purchased a number of Copperhead CLGMs from the US for the purpose of developing doctrine and concepts for the future employment of precision munitions. This ammunition provides the capability to designate and destroy stationary or slow moving targets with a high degree of accuracy. The initial purchase was limited, and the replacement for the Copperhead has yet to be determined.

Delivery Systems

The second aspect of the effects system is the delivery system. Often seen as the entire capability, especially by artillery officers, this subsystem is the most obvious aspect of the RAA indirect firepower capability, yet makes up only a small but important part of the overall capability requirement.

The ADF is currently equipped with three artillery delivery subsystems. These are: the 155-millimeter M198, the 105-millimeter L118/9 and the 105-millimeter M2A2. The L118/9 replaced the M2A2 in active RAA artillery units in 1988, with the M2A2 now being used in the part-time forces. This thesis will only discuss the M198 and L118/9 systems, as these will be the primary systems which the RAA will need to consider to match the AAN concepts and meet capability requirements. However any capability replacement project must consider the capability of the reserve units and not provide them with second class equipment. The capability of the reserves to compliment the regular forces in the future will increase and must be considered as part of the "Total Force."

The M198 is a towed 155-millimeter howitzer, designed to provide general support[11] and close support[12] field artillery fire to supported formations. It was introduced into the ADF in the 1980s and equips both regular and reserve artillery units. The ADF currently uses the M107 ammunition system and has a number of CLGM Copperhead rounds for a limited precision capability. With the M107 projectile and propellant systems the M198 is able to achieve a range of 18,150 meters or 30,000 meters with a rocket assisted projectile.[13] The CLGM Copperhead, has a maximum range of 16,400 meters.[14] The M198 system currently weighs 7163 kilograms[15] and can be lifted tactically with the CH-47D, and strategically with the C130 aircraft.

The delivery system can fire a variety of ammunition types, including the latest range of DPICM, precision and smart munitions, and sensor munitions, including radio jammer sense and destroy armor (SADARM), extended range full bore (ERFB) ammunition, and the future extended range DPICM XM982 projectile. The XM982 has an expected range for towed howitzers of 40 kilometers unassisted and out to 57 kilometers with 52-caliber barrel versions.[16]

The 105-millimeter L118/9 is a lightweight towed weapon and is deployed in all full-time field artillery units. The system was purchased originally with two barrels per weapon. These barrels, designated as L118 and L119, permit the RAA to fire the Abbot ammunition systems using the British L118 barrel and train with the less expensive US M1 ammunition using the L119 barrel. Due to the cost of the Abbot system, the RAA adopted the L119 as the operational barrel for the RAA. The L118/9 weighs 4,000 pounds, is air transportable with its basic load of ammunition by the UH70 helicopter. It

has dual lift capability with the CH47 Chinook. The prime mover for the L118/9 is the Mercedes Benz Unimog truck.

The US Army purchased the L119 from Royal Ordinance in 1987 and fielded the first unit in 1989.[17] The US Army has slightly modified its systems and designated its version the M119A1. This system uses the same barrel as the RAA L119, except the US Army has developed a new ammunition system for the 105-millimeter gun and no longer uses the M1 ammunition system for its M119. The improved US ammunition is much more capable than the M1 system and includes both HE and DPICM rounds. The ADF currently has a long-term-standing contract for the supply of 105-millimeter ammunition from the Australian Defense Industries (ADI). ADI manufactures the 105-millimeter M1 ammunition for the ADF and has the capability to manufacture the British Abbot 105-millimeter ammunition. The new munitions manufacturing facility at Benalla in Victoria is not equipped to manufacture 155-millimeter ammunition. Discussions with the General Manager of ADI's Ordnance Marketing on indicated that "when we were setting up our new manufacturing facility at Benalla (1998) we asked over and over again the capability we were to install and were told definitively that 105-millimeter HE M1 was here to stay and not to consider 155-millimeter at all. Yet only last week was I told that there was a distinct move to 155 millimeter"[18] (ADI 1999). The impact for Australia is a reduction in the ability for the ADF to be self-reliant in ammunition production if there is a move away from the 105-millimeter M1 or Abbot ammunition systems. Also changes to the manufacturing requirements will now result in an additional cost to the manufacturing process, and highlight a lack of strategic awareness for future development. This underscores the critical requirement for a coherent strategy by the

RAA, integrating all elements of the system to become a capability based Army. Also, without a 155-millimeter ammunition production capability, the ADF will rely upon countries such as the US, South Africa, Israel and Singapore for 155-millimeter ammunition supplies. This does not provide a robust solution should any diplomatic problems arise during future regional conflicts.

Should the ADF purchase the Abbot system, the operational range of the delivery systems is 17,200 meters using charge super.[19] The ADI factory at Benalla has the capability to manufacture the Abbot ammunition, but the cost of the ammunition has limited its employment to date. The current operational range of the L119 using the M1 ammunition systems is 11,500 meters.[20] Should the ADF purchase extended range ammunition from the US for use with the L119, this range may extend to 14,000 meters with unassisted Zone 8 ammunition and 19000 meters using rocket assisted ammunition.[21]

The importance that history has played in the development of the RAA capability was described in the previous chapter. The ammunition systems for the RAA have also been heavily influenced by the historical setting in which the RAA has performed. The lack of advancement in the field of effects, namely the ammunition systems for the RAA, may be the result of not having deployed operationally since Vietnam and having retained the Vietnam era capability up to the present. The Vietnam-era capability was also reinforced by the involvement of Australian forces in areas, such as Malaya and Indonesia, leading up to the Vietnam conflict. No detailed analysis has been conducted into the types of effects the RAA will be required to achieve in the future.

Summary

The RAA's maintenance of the 105-millimeter M1 and the 155-millimeter M107 ammunition systems until 2010, when the delivery systems are due for replacement, would seriously jeopardize the RAA's doctrinal and technical preparation for the AAN. A gradual investigation of newer effects systems with the current legacy delivery systems is needed to provide an enhanced capability for the RAA and the AAN. This investigation must also address the range of current and future ammunition systems. No improvement in range will afford an increased capability if the new ammunition system does not improve the accuracy of the effects and if the effects system improvements are not coincident with improvements throughout the other components of DESS.

Sensor Systems

This section will only discuss those primary sensors that are currently available to the RAA. The underlying theme with an information age force will be that every soldier becomes a sensor. All soldiers will be able to acquire information and pass that information through a distributed secure information network to the necessary processing center where an effect will be determined. Current sensor systems available to the Army-in-Being are armed reconnaissance units, aviation reconnaissance units, regional force surveillance units, infantry reconnaissance patrols, and UAVs. Many more systems exist in the joint and combined areas that will be available during coalitions operations. The RAA will need to broaden the way it currently employs sensors, to fully embrace the AAN's network-centric warfare.

The RAA's sensor systems consist of active radar systems, such as the AN/TPQ-36 weapon locating radar (Q36) and the RASIT B ground surveillance radar, and passive

systems, such as the AN/TNS-10 system, AN/TAS-6A thermal surveillance systems, and human observers.

AN/TPQ 36 System

The AN/TPQ 36 performs the function of target acquisition by detecting and locating hostile indirect fire weapons once they have fired. The system is capable of detecting both mortars and guns out to a planning range of 15 kilometers and rocket systems to a range of 24 kilometers. The radar is ideally suited to a response systems, such as the M198, due to the complementary ranges of the two systems. When allocated with a control status of reinforcing or general support to an L119 unit, the radar has a range overmatch and is not utilized to its fullest potential, due to the limited range of the L119 system with the M1 ammunition system.

The AN/TPQ 36 is also capable of directing the artillery fall of shot of friendly units to great accuracy and is normally regarded under rules of engagement to be observed fire. This is the only system that can engage hostile units with observed fire through the entire range of the L119 and M198 delivery systems. Conventional observation using a ground observer is limited to the observer's line of sight and is, under ideal conditions, out to approximately 3000 meters.

The current fleet of AN/TPQ 36 radars has a life of type (LOT) of 2002, with the option of having that extended to 2005. The current radars are using Version 3 software and hardware configuration. The main user of this system, the US Army, upgraded its fleet of AN/TPQ 36 radars in 1998 to Version 8. This upgrade included significant changes to the computer systems, ensuring that they are compatible with newer

computing systems currently available. The Australian AN/TPQ 36 systems were introduced into service in 1987 and by 2002 will have been in service for fifteen years.

Extending the LOT of the AN/TPQ 36 will pose serious challenges to the ADF, due to the nature of the equipment. Unlike weapons systems, such as the M198 and L119, which are capable of being extended in service almost indefinitely, the availability of electronic components may preclude the extension of the LOT for the AN/TPQ 36 past 2005. Also, with the increasing capabilities of ammunition systems and longer barreled delivery systems, the extension of the current capability to 2005 will reduce the capability of the system to acquire longer range weapons.

Figure 1 indicates the ranges of regional delivery systems and compares these ranges to that of the current AN/TPQ 36. Table 2 provides the detailed information for the graph at figure 1. An analysis of the information at table 2 indicates that only 27 percent of the regional delivery systems can be acquired by the AN/TPQ 36 and 26 percent of the systems have a greater range than the M198.[22] Figure 1 also displays those delivery systems that have appeared in the region since the AN/TPQ 36 systems were brought into service in 1987. As discussed in the effects section above, the clear trend is to longer range systems. In ten years this trend should see the continued reduction of Army- in-Being's ability to acquire these targets.

Table 2. Regional Delivery Systems and Ranges.

	Weapon Type (Cannon)	Range (m)	Ammunition Type	New or entered Service in region in the past 10 yrs
1	85mm Type 56	15650		
2	105mm Hamel Light Gun	11500	M1	
3	105mm M101A2	11270	M1	
4	105mm M101 Upgraded	14500		Yes
5	105mm Giat LG Mk II	11500	M1	
6	105mm Giat LG Mk II	15000	HE HB	
7	105mm Giat LG Mk II	17500	HE BB	Yes
8	105mm M56 Howitzer	13000		
9	105mm M102	11500		
10	105mm M102	15100	HERA	
11	105mm Model 56 P How	10575		
12	122mm Type 54 How	11800		
13	122mm Type 85 How SP	15300		
14	122mm D-30	15300		
15	122mm D-30	18000	ERFB	
16	122mm D-30	21300	ERFB BB	
17	122mm M1938	11800		
18	130mm Type 59-1 Fd Gun	27150		
19	130mm M46	27150		
20	152mm Type 66 Gun/How	17230		
21	152mm Type 83 Field Gun	30000		
22	155mm WAC-21 Gun/How	30000	ERFB	
23	155mm WAC-21 Gun/How	39000	ERFB BB	Yes
24	155mm XP-52	34000	ERFB	
25	155mm XP-52	43000	ERFB BB	Yes
26	155mm FH2000	24000	M107	
27	155mm FH2000	30000	ERFB HB	
28	155mm FH2000	40000	ERFB BB	Yes
29	155mm FH70	24700		
30	155mm FH70	31500	BB	
31	155mm M198	18150	M107	
32	155mm M198	22000	M483A1	
33	155mm M198	30000	RAP	
34	155mm FH88	19000	M107	
35	155mm FH88	24000	ERFB HB	
36	155mm FH88	30000	ERFB BB	
37	155mm GHN-45 GH	30300	HE BT	
38	155mm GHN-45 GH	39600	BE BB	Yes
39	155mm PLZ45	30000	ERFB	

	Weapon Type (Cannon)	Range (m)	Ammunition Type	New or entered Service in region in the past 10 yrs
40	155mm PLZ45	39000	ERFB BB	Yes
41	155mm M114	18300	M107	
42	155mm M114	22500	ERFB BB	
43	155mm M71 Gun/How	23500		
44	155mm M71 Gun/How	30000	BB	
45	155mm GC 45 Gun/How	30000		
46	155mm GC 45 Gun/How	39000	BB	Yes

Source: Foss 1998-99.

Any replacement or upgrade of the AN/TPQ 36 system must complement future artillery systems. This will force the RAA to develop the future artillery concept sooner than previously thought, and well within the ECF timeframe. In order for the AN/TPQ 36 replacement systems to be procured in 2005, the force development process must commence now to initiate the funding process. This process, however, has yet to begin.

AN/TNS 10 System

The AN/TNS 10 sound ranging system is a passive system utilizing acoustic microphones for the detection of the sound of large caliber guns and mortars. The concept was originally developed in World War 1 and has been in service with the RAA in various forms since approximately 1952. The most recent upgrade to the existing systems occurred in 1987, with the provision of radio link communications capability, significantly reducing deployment and redeployment time.

The future of the current system is uncertain, with no clear direction from the RAA hierarchy. In recent years, escalating maintenance problems and the lack of spare parts have contributed to the system's obsolescence. This means that the only system available to acquire hostile indirect systems is the AN/TPQ 36 radar or visual

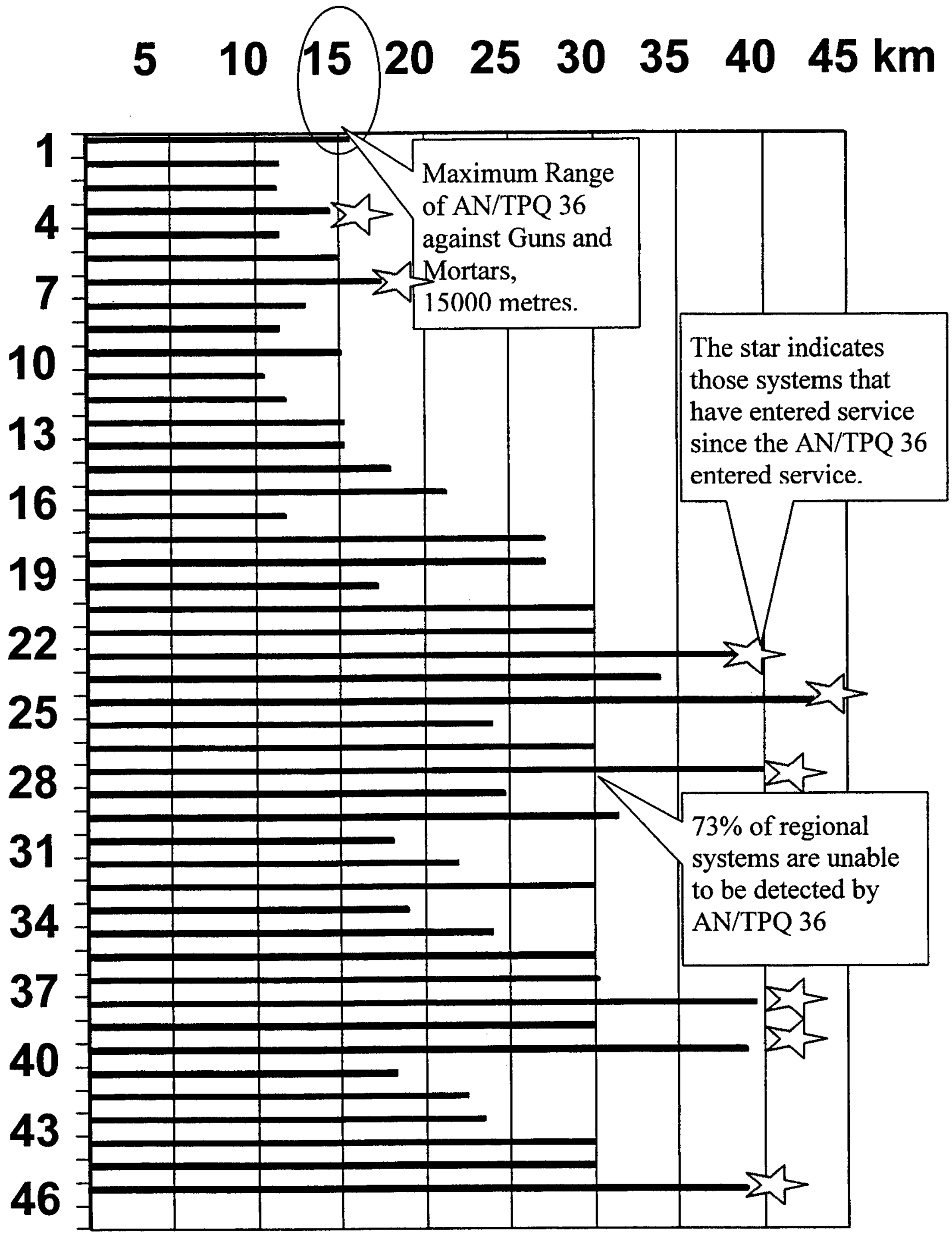

Figure 1. Asia Pacific Delivery Systems showing maximum ranges of guns and mortars only. Source: Foss 1998/99.

observation. This also means that the RAA has no long-range acquisition systems now available.[23]

The AN/TNS 10 was a former divisional asset, able to cover a large area passively, as well as across brigade borders. This permitted the RAA to support each brigade with only one AN/TPQ 36 radar when deployed in the traditional linear battlefield and divisional structure, reducing the need for duplication of active systems. Additionally the passive AN/TNS 10 was able to cover the gaps when the AN/TPQ 36 was either moving, undergoing maintenance or resting the crew. With the demise of this capability, the operational tempo of the AN/TPQ 36 radars has been increased to cater to the increased demand.

A passive system on the increasingly "active" battlefield can offer a significant knowledge edge over an adversary. The system is able to track multiple activities simultaneously, and, with the increasing sophistication of jamming systems and anti-radiation missiles, this function dramatically increases the survivability of the active system on the battlefield by reducing potentially dangerous emission time.[24]

Both the British and the French Armies still employ some form of acoustic ballistics target detection systems. The British are expected to purchase the hostile artillery locating (HALO) system as part of their advanced sound ranging program. HALO will compliment the counterbattery radars of the British, French, and German Armies, providing both a queuing system for the radar and redundancy to the target acquisition system, without the need for a large number of expensive radars.[25] The

HALO system was field tested in Bosnia with both IFOR and SFOR, providing locations of weapons that fired in violation of the Dayton Peace Accord.[26]

Joint Offensive Support Teams

The Joint Offensive Support Teams (JOST) acquire the majority of targets for the RAA. Generally four JOSTs, each consisting of four personnel, are employed per battery, and are usually distributed to a scale of one per maneuver company. JOSTs are transported by the same means as the supported maneuver units to ensure continuous observation and fire support. They are equipped with devices, such as laser range finders for target acquisition, but are limited to the range of visual observation. Currently[27] no forward observers are equipped with target acquisition thermal imaging devices, and the ability to acquire and observe targets during periods of poor visibility and through battlefield obscuration is poor.

JOSTs are part of the formation artillery observation and target acquisition plans, designed to support units and formations as a whole (MLW 2.1.1. 1995, 4.193). This plan is part of the surveillance plan determined in concert with the regimental JOSCC and by the supporting HQ staff. However, due to the poor target acquisition devices employed by the JOSTs, their ability to conduct surveillance and target acquisition tasks is limited to daylight hours and to approximately 3000 meters (visual range). Additionally, when the JOST is deployed as per the surveillance plan, the ability to provide support to the maneuver unit is severely reduced.

The current ADF PROJECT NINOX Land 53 seeks to give the Army a range of night fighting equipment, all-weather detection, and surveillance and target acquisition systems, including long range thermal and radar systems designed for STA operations.

Each field artillery regiment is to be equipped with a minimum of two ground surveillance radars (GSR), plus thermal surveillance systems and unattended ground sensors.[28] The latter will dramatically improve the JOST's ability to conduct all-weather, 24-hour STA operations. The challenge for the RAA will be how these systems will be employed, carried, and linked into the overall brigade surveillance and information collection plan.[29] ADF doctrine for GSRs has not matured to the point of providing a foundation for employing them.[30] Friction may also arise in the future between the supported maneuver unit and the requirement for continuous long-range surveillance now offered by these systems. The limitation of having no specifically configured JOST vehicles in the RAA will also severely restrict the employment of these new NINOX systems to the engagement of only the most static of targets and battle positions, due to the requirement for the JOST to dismount and set up the equipment.

While the new sensors will greatly improve the RAA's and ADF's ability to conduct STA operations throughout the battlespace more effectively, the limitation of no doctrine and no dedicated STA vehicles available to the JOST will curb the ability to "fight smart" with the NINOX equipment. Examples of these vehicle include the British warrior observation platform vehicle (OPV) and the US BFIST-V. Both of these vehicle have integrated navigation systems, both GPS and inertial based, aligned to a target acquisition system (both laser and thermal) and, in the case of the BFIST-V, a laser designator for PGMs.

Furthermore, the issue of information flow from the JOST to both the BC and regimental JOSCC has yet to be resolved. The increased volume of information associated with these sensors may overwhelm the small battalion or regimental JOSCC

staff. The regimental JOSCC staff will now have control over the movement of battery observation assets to ensure they meet brigade requirements, something that formerly had been devolved to the BC. Complicating this issue is the requirement to coordinate all lethal and nonlethal effects. This implies that assets such as fire support systems and observers will become more centrally managed and tasked, not always in accordance with the lower maneuver commander's desires, but in line with the higher commander's intent.

The US artillery is developing an effects coordination center (ECC) concept. This cell will coordinate all elements of effects, both lethal and nonlethal, in the tactical headquarters, and will be coordinated through time and space on the battlefield. This concept will result in the responsibility to move, position, fire and sustain delivery platforms will be separated from the responsibility to coordinate the effects delivered by the platform. ECCs will be separate and discrete cells designed to better fuse the command decision-sensor-actor linkages and better support the targeting process. This implies that, with the introduction of more sensors into the ADF, there may be an increasing need to centralize the information flow and change the way in which the RAA presently conducts the command and control of effects systems. This does not mean the centralization of assets, but rather better control of information management and the willingness to direct assets in accordance with the higher commander's plan.

While the presence of a JOST with the maneuver unit is unlikely to change, the largest impact will be in the way the battalion, brigade, and joint task force control the application of lethal and nonlethal force. It may be necessary to establish a separate administrative cell for the conduct of movement and administration of firing units. This

effectively moves sustainment and movement aspects, currently inherent in the functions of the JOSCC, into a separate area away from effects coordination.

Summary

RAA support for the AAN must be considered well before the AAN timeframe, and even before 2010. The sensor systems that are being introduced into the RAA through the NINOX project and the requirement to consider the upgrading or replacement for the AN/TPQ 36 and AN/TNS 10 systems will force the consideration of this component of DESS in the short term. These systems will influence the capability of the future effects systems that the RAA needs to support the AAN.

The RAA must maintain both passive and active sensor systems to provide flexibility to the commander and ensure survival on the future battlespace. Currently the RAA has no strategy for the development and incorporation of new sensors, nor for the enhancement of existing sensors, to support the AAN. The integration of BCSS operating in a network-centric warfare environment, incorporating NINOX and enhanced STA systems, along with multiple sensors from other services, will seriously challenge the RAA to move from the Industrial to the Information Age.

With the increasing reliance upon information and sensors, the traditional demands placed upon the JOST will increase, intensifying the requirement for a fully integrated and mission orientated vehicle, the lack of which continues to hamper the development of doctrine and procedures to support the Enhanced Combat Force and inform the capability development for the AAN. Competing demand for the JOST to be involved in a higher formation information collection plan and to support the maneuver

commander in the traditional sense will force the review of information management and use of sensors by the RAA on the battlefield.

Doctrinal Deficiencies

A number of doctrinal deficiencies exist in the present RAA sensor system. RAA Corps Training Notes 3-6 states that the normal allocation of one weapon locating radar troop consists of one AN/TPQ 36 per brigade, yet this will always depend upon the threat (para 1-10). This deployment scenario was based upon a linear battlefield and the assumption of the ability to rely upon passive AN/TNS 10 systems to cover movement and maintenance down times. Independent brigade operations covering large distances, as required in the Defeating Attack against Australia (DAA) strategy described in Defense White Paper 1994 and Strategic Review 1997, would require more than one AN/TPQ 36 system to be able to adequately cover the entire brigade area. The movement away from a linear battlefield of the mid 1980s and into the dispersed battlefield of Northern Australian and offshore deployment in the littoral environment (JSCDFADT 1999, 2) will require a doctrinal amendment in this area.

This deficiency was most recently highlighted in the Army 21 trial, when two AN/TPQ 36 radars were deployed in support of each motorized battalion within the DAA strategy. Had this structure been adopted across, 1st Brigade, 3rd Brigade and 7th Brigade, this force structure would have required an additional eight AN/TPQ 36 systems to conduct the DAA strategy.[31]

The Army 21 trial assumed that each battalion would operate over such a vast distance within northern Australia that each infantry battalion could not rely upon the

battlefield operating systems coverage of the higher brigade. The region was divided into focal areas where the majority of operations were conducted. This is illustrated in figure 2.

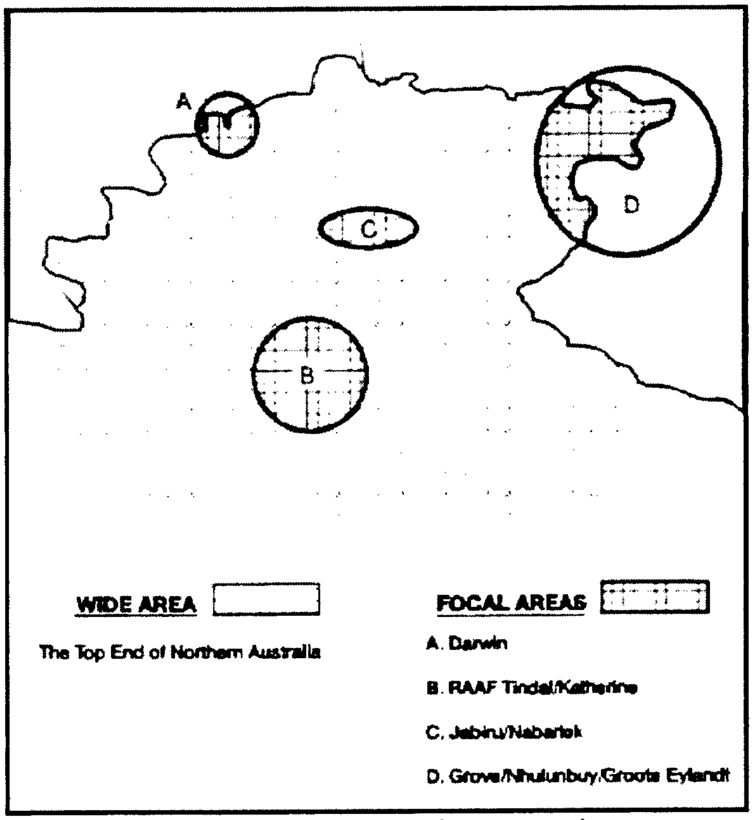

Figure 2. This figure highlights the noncontiguous nature of the battlefield in current doctrine. Source: *Manual of Land Warfare* 2:1:1, Employment of Artillery, 1995, figure 11-22.

Within this setting each battalion was allocated assets which included a f

ire support company, consisting of 105-millimeter and 155-millimeter delivery systems, as well as LAV 25 vehicles for direct fire support, engineers, two AN/TPQ 36 radars, and an artillery survey and meteorological capability. Whilst the outcome of the Army 21 trial indicated that the feasibility of grouping down to such a level was sound, the ability

to train and maintain a level of technical competence was diminished and severely detracted from the unit's long term capability. The trials highlighted that it is still necessary to allocate at least two AN/TPQ 36 radars to each focal area when operating over such vast distances.Also the demise of the AN/TNS 10 acoustic capability increases the requirement for additional radars. Operations in Northern Australia, with defense-orientated around static installations and dry flat terrain, are ideal deployment areas for acoustic sensors. The combination of both an acoustic surveillance and target acquisition system with an AN/TPQ 36 to support mobile and reactive operations is ideally suited to the DAA and offshore strategies in SR 97. The failure to maintain the acoustic capability has created an over-reliance upon AN/TPQ 36 systems. This, combined with the AN/TPQ 36's LOT occurring in 2002 to 2005, highlights a deficiency in the systems approach to capability and indicates that the RAA has yet to become a capability led and focused force.

The current doctrinal employment and quantities of STA assets have not been reevaluated with changing strategic concepts since the introduction of the capability in 1987. This highlights the requirement for a review of capabilities when new strategic guidance is provided to ensure that the RAA is capable of meeting the entire spectrum of tasks across the entire RAA capability. SR97 highlights a more offshore focus for the ADF; a review of assets available to meet this employment option must also take place to ensure that sufficient forces are available to the ECF and the AAN.

Equipment Deficiencies in Sensors

In the past, active radars and passive acoustic sensors were used as complementary systems to cover the divisional area. The dispersion of this area and the requirement to cover the threat from all angles of approach have dramatically increased the requirements for additional sensors. No modifications have been made to rectify this situation, and with the impending obsolescence of the AN/TNS 10 acoustic sensors this situation will become even worse.

The RAA has not deployed artillery in conflict since the Vietnam War.[32] The US Army is the most significant user of the AN/TPQ 36 outside of Australia and has deployed the system on numerous peacekeeping and warfighting operations since the Vietnam War. Such operations provide the RAA valuable insight into the style of both peace support and warfighting. Operations such as Lebanon 1982, Desert Storm 1991, Somalia 1993, Bosnia 1996, and Kosovo 1999 have involved the deployment of artillery sensors such as the AN/TPQ36. The UK and French militaries have deployed systems utilizing passive acoustic microphones, similar in concept to the AN/TNS 10 systems, to detect indirect fire systems, as well as conduct surveillance of ground and air targets.

The outcomes for the US operations where AN/TPQ 36 systems were used indicated that numerous systems were required to provide round-the-clock coverage for the forces involved. This is similar to the outcomes of the Army 21 trials. During OPERATION RESTORE HOPE, the US deployed three AN/TPQ 36 radars to the vicinity of the airfield in Mogadishu. Two of these radars were operating at any one time, with the third undergoing maintenance and crew rest or able to surge for peak periods, usually at night. The US found that AN/TPQ 36 operators were in critical

supply because of the inability to replace the crews with other personnel from within the deployed forces, due to the specialist training required.[33] With only three radars in the deployable ADF and only two of these fully manned, the RAA has a critical equipment and personnel shortfall, should it be required to deploy to a peace enforcement operation where an appropriate threat exists.

Had the ADF required AN/TPQ 36 support for the current UN mission in East Timor, based on the analysis from OPERATION RESTORE HOPE and the Army 21 trials, a minimum of four radars would have been required.[34] This would have provided coverage of the Dili area initially and the ability to support mobile operations on the East and West Timor borders for the remainder of the deployment. The deployment of an acoustic sensor system, such as the AN/TNS 10, to cover the Dili area and surrounding areas, could reduce the requirement for the AN/TPQ 36 radars to two.

With the expected duration of the UN mission in East Timor to be at least 24-36 months, rotation of the AN/TPQ 36 crews would be necessary. This rotation force would require another two AN/TPQ 36 radars to replace those in country. Therefore, at any one time the ADF would require a minimum of four fully equipped, deployable and manned AN/TPQ 36 systems, plus additional crew to replace those of the acoustic sensor system. The two systems and crew returning to Australia would require rest and recuperation, necessitating at least one if not two more crews undergoing training to replace those now in East Timor. The ADF does not have four trained crews for the AN/TPQ 36. Four AN/TPQ 36 radars are available for deployment;[35] however additional spare parts and maintenance personnel would be also required. The RAA was lucky the situation in East Timor did not deteriorate. The RAA is presently only able to support short duration

operations with the AN/TPQ 36 due to the lack of trained personnel. This also highlights that the RAA continues to undervalue the capability of the acoustic sensors at their disposal and shows a lack of understanding of the requirement for the deployment of specialist sensor systems such as the AN/TPQ 36 and AN/TNS 10. The current level of officer education concerning the awareness of the entire RAA capability needs to be increased to overcome these issues.

Supporters

There are three main supporters to the field artillery system: meteorological, survey, and calibration systems. These systems' contribution to the resolution of the artillery's overall ballistic problem is significant. Without current meteorological information, accurate survey and calibration data, the best artillery ammunition target acquisition systems or delivery systems will not be able to accurately and consistently engage targets.

Advancements in guidance packages may see a reduction in the requirement for some of these systems. All guidance correction systems rely, however, on the projectile's being placed in the vicinity of the target area, and then their being required to make only small corrections for precision. Large corrections may still result in the projectile's missing the target.

Meteorological System

The MARWIN MW12 is the current meteorological system used by the RAA. The MARWIN MW12 is a state-of the art meteorological atmospheric sampling system, with similar systems being used throughout the world by most weather bureaus, including the Bureau of Meteorology in Melbourne, Australia. The MARWIN MW12 came into

service in 1987 and has a LOT of approximately 2010. Due to the limitation of the quantity of this equipment, only two such systems are deployable to the RAA, with the other two systems being used in training or at proof and experimentation installations. Specialist training and scarcity of assets have resulted in the assets being centralized at the 131st Locating Battery.

During peacetime, the systems are generally deployed one per regiment, (18-gun battalion) depending upon their requirements. During operations this is doubled, to include two per regiment-size group, to ensure guaranteed 24-hour operations, maintenance, and servicing of equipment failure.[36] There are no manual meteorological systems currently in service.

The original scale of the MARWIN systems was based on the former linear battlefield deployment scenario. During linear division operations, one meteorological troop equipped with two MARWIN MW12 systems supported the divisional artillery and disseminated meteorological corrections throughout the division area. With the demise of the divisional artillery headquarters and the restructuring of the ADF based around the brigade as the nucleus of operations, the number of MARWIN systems and trained personnel have proven to be inadequate to support either decentralized operations in northern Australia, as per Defense White Paper 1994, or dispersed brigade and littoral operations as per SR 97.

Presently the only backup means available to the RAA if the MARWIN systems become inoperative is to fire a registration mission using one of the regiment's gun batteries. In dispersed operations this would require each battery to fire such a mission

due to the area of validity for meteorological correction only extending 30 kilometers from the point of origin.

"Employment of indirect fire in DAA will be influenced by the imperatives of minimizing collateral damage, the timely concentration of fire, and minimizing the ammunition and time needed for adjustment of observed fire on to a target" (Combined Arms Training Center Minute 6675/4/4, Artillery Survey through to the AAN, 1st draft). When deployed in widely dispersed areas on DAA tasks, each section of three guns would need to conduct a registration mission. To ensure first round effectiveness up to eight missions would need to be fired per day to ensure correct meteorological data. In DAA operations this could result in 48 missions per day per regiment just to acquire current meteorological data.[37] The cost of one day's operation firing these registration missions would be on the order of $115,200.[38] With the cost of a new MARWIN system at approximately $450,000, this would mean that for every four days of operations in a DAA scenario in Northern Australia, the cost equivalent of one new MARWIN system is expended.[39]

The present number of meteorological systems and personnel in the RAA is inadequate to support dispersed RAA operations. Requirements to support archipelagic operations in accordance with FLW 2030 have yet to be determined. Once this occurs the RAA meteorological concept to support the AAN must be determined.

Survey Systems

The RAA's present survey capability consists of gyroscopic orientation systems, optical theodolites and electronic distance measuring equipment. Survey equipment and personnel are deployed at only one full-time field regiment, with no survey capability at

the 8/12 medium regiment. Both of these units have been placed at high levels of readiness in line with the increased readiness across the ADF for the peacekeeping operation in East Timor. The survey equipment used throughout the RAA varies in obsolescence, with the Gak-1 Gyro used for orientation within the RAA determined obsolete and irreparable by Support Command Australia in September 1997. Similar systems however exist in the civilian community, identical to the current Gak-1 gyro, offering the ability to maintain this equipment well into the future.

The present state of this capability is at the best uncertain. The Combined Arms Training And Development Center (CATDC), which has the responsibility for the future direction of all combined arms capabilities, has expressed a desire for the future RAA survey capability to be a combination of GPS and inertial navigation systems. Discussion within the RAA has included the option of totally decentralizing the survey capability to the artillery regiments and not maintaining the present tiered level of survey responsibility throughout the RAA. Regardless of what form the capability takes, the equipment and capability will continue to be relevant into the future and for the AAN.

DAA operations, whilst perceived to be low-intensity, place a larger burden upon the supporter systems within the RAA capability. Again, the RAA's equipment specific policies precluded any detailed analysis of the increased tempo of supporter systems. If a capability analysis had been conducted once the DAA strategy was introduced in the late 1980s, an increase in the quantity of supporting systems and personnel may have resolved this issue. One possible outcome may have been a restructure of the RAA.

Calibration

The resolution of the calibration problem has almost been solved through the introduction in service of individual muzzle velocity measuring equipment (MVME). This system tracks the velocity of the projectile from the delivery means and provides the ability to continually update the ballistic solution to improve accuracy. The integration of MVME and the future BCSS systems will be required when the BCSS system is incorporated down to the individual delivery system.

Summary

The supporter aspects of DESS are insufficient in quantity to be able to adequately support current strategic guidance. Doctrinal modifications over the past 10-15 years have not translated into modifications of capabilities to support changes in deployments and strategic guidance. Supporting systems of the RAA are an area that is often neglected at the unfortunate expense of the entire capability. Technology may be able to overcome some components of the supporting systems in the future, but until this occurs the RAA must develop an enhancement program for the supporters to ensure the RAA is able to support the AIB, ECF and the AAN. This also highlights the importance of a holistic approach to the future RAA capability.

Conclusion

The ADF is in a transition from a force designed primarily for the continental defense in benign strategic circumstances to one suited to the needs of an uncertain future and the proactive maritime strategy required by the SR97. The JSCFADT submission, published in April 1999, stated that there remains some significant capability deficiency in critical areas if the Army were required to engage a modern combat capable adversary.

"Australia would be able to offer a brigade sized contingent for a warfighting contingency in a coalition setting, but with considerable risk, and it is likely that the contingent would be deficient in aspects of firepower, maneuver and force protection. Areas that presently suffer capability limitation are Ground Based Air Defense Systems, rotary wing assets, indirect firepower assets, nuclear and chemical and biological defense" (p 14).

The introduction of NINOX equipment and the deficiency in sensor and support systems in adequately supporting the current strategic guidance indicate a lack of awareness of the RAA's future requirements. The East Timor deployment highlighted that the traditional build-up and training phase is unlikely to enable new equipment to be purchased or personnel to be recruited and trained prior to deployment. In the quest for the ADF and the RAA to be a concept led and capability focused military, there is a need for an overarching strategy to define what capability is required and where all of the components of that strategy fit together. It is clear that a strategy based upon a "system within systems" approach, incorporating all elements of the DESS, is needed for the RAA in order to determine the requirements for the AAN.

History has shaped the present capability and will continue to shape the force structure. Deficiencies need to be highlighted and articulated in a coherent strategy to ensure that the RAA is able to look to the future and embrace the enhancements that technology will provide. All elements of the DESS must be continually updated. The requirement to only consider the development or enhancements to legacy systems until a prescribed date is no longer applicable to the changing nature of technology and warfare. Past practices of equipment replacement policies are no longer applicable for the future.

The requirement is to consider the continual enhancement of the RAA capability across the DESS. The need to change present delivery systems should not be driven by the requirement to upgrade the system in 2010, but rather by other factors, such as improvements in munitions, the introduction of sensor systems, the requirement to modify existing sensor systems, and the need to maintain a level of technological relevancy in the Asia Pacific region. The requirement to upgrade delivery system is only one factor in the overall capability for the RAA.

The introduction of the BCSS system only down to company headquarter equivalent level will maintain the notion of mass for the delivery systems. A system which permits the deployment of delivery systems as individual components not reliant upon a centralized ballistics computation process will move the RAA ahead into the Information Age. The RAA must link all sensors across the battlespace, not just JOSTs and the RAA hierarchy. Anything less than this is automating the existing process without embracing the true notion of digitization in a maneuver warfare environment.

The RAA must move forward in effects management and through the adoption of a more accurate and efficient ammunition system. Current legacy systems have the potential for substantial improvement in range and capability if the systems are matched with improved ammunition systems. The procurement of enhancement munition systems will enable the RAA to improve the ECF capability and greatly inform the RAA of the way ahead for the AAN. The greatest potential advantage for the RAA lies in further developing the C4ISTAR capability and linking this capability through a network-centric warfare environment throughout the ADF.

[1]The normal allocation of a Joint Offensive Support Team is one team of four personnel to each maneuver company. This does not include Armored or Cavalry units as their support has previously been provided by Medium Caliber 155 millimeter systems. The 155 millimeter artillery unit are only equipped with two JOSTs per battery and allocate the JOSTs as required to the maneuver units.

[2]Intelligence Surveillance Target Acquisition and Reconnaissance.

[3]Major General Peter Gration, at the disbandment ceremony, June 1998.

[4]Staff Officer Indirect Fire Weapon Systems SO2, Land Weapons Systems, Support Command Army, 30 September 1999.

[5]BCSS Project Manager 27 August 1999.

[6]Discussion with the BCSS Offensive Fire (OF) Project manager indicate that the BCSS (OF)will only provide a command support system to coy headquarters level mounted and dismounted. For Artillery Regiments it will be provided to Battery Command Posts, Regimental HQ, Logistics HQ, JOSCC, Battery Commanders and to JOSTs, 6 February 2000.

[7]For artillery and mortars the infliction of casualties is best achieved using HE, particularly during the first 10 to 15 seconds of an engagement, before the enemy has time to take cover or evasive action. Manual of Land Warfare, Part 2, Volume 1, Pamphlet 2, Application of Fire Support, 1988, p2.33.

[8]These figures are taken from the Australian 4 th Field Regiment SOPs which includes 120 rpg, with 102 rpg HE (78 Point Detonating, 24 Variable or Mechanical time fused), 8 Smoke, 6 Illumination, 2 Anti-personnel rounds no longer available and 2 smoke marker rounds only available from the L118 ammunition system. The numbers for the US Artillery Battalion were provided from the National Training Center at Fort Irwin, as a standard configuration for conventional warfare.

[9]National Training Center, Fort Irwin, accessed at www.irwin.army.mil/wolves/class_v_ubl.htm on 28 December 1999.

[10]This 23 percent was determined by the comparison between HE and DPICM projectile only, not the entire 5544 rounds in the US FA BN.

[11]Weapons designed for the provision of additional fire support for formations at all levels. (ADFP 101 Glossary)

[12]That action of the supporting force against targets or objectives which are sufficiently near the supported force as to require detailed integration or coordination of the supporting action with the fire, movement or other actions of the supported force. (ADFP 101 Glossary - NATO definition)

[13]Christopher F. Foss, *Janes Armour and Artillery*, 1998/99, p749

[14]Ibid

[15]Ibid

[16] Terry J. Gander and Charles Q. Cutshaw, Janes Ammunition Handbook 1998-99, 298

[17] Christopher F.Foss, in Janes Amour and Artillery, 1998-99 p752

[18]This conversation occurred through an email between the General Manager of ADI's Ordnance Marketing and the author on 9 August 1999.

[19]Ibid., 745

[20]Ibid.

[21]Ibid., 752.

[22]To determine these figures, the assumption that all delivery systems would fire at maximum range as indicated in Table 1. Where a delivery systems has the option of firing different ammunition systems, all of theses ammunition ranges were used, to increase the possibility of detection by the AN/TPQ 36. If the range of the ammunition was greater than 15000 meters, it was determined to be undetected by the AN/TPQ 36 radar (gun and mortar ammunition only). When ammunition systems were able to fire greater than 30000 meters, they were determined to have greater capacity than the M198.

[23]The AN/TNS 10 system is capable of detecting 155 millimeter caliber weapons and larger systems to a range of 25km or 2.5 times the length of the microphone base length. A conventional based length is normally 10km, resulting in up to 50m accuracy out to 15km and between 50--100m accuracy for detections out to 25km.

[24]During the RISTA trial, a systems called MUBASS was developed by DSTO to replace the AN/TNS 10 systems. MUBASS was able to detect not only hostile firings to a much greater accuracy and range than the AN/TNS10, but also conduct battlefield surveillance against air, ground, maritime and sub-surface target in the littoral. The

MUBASS systems was not pursued due to the bureaucratic problems associated with the force development process where a conflict between the capabilities of MUBASS and the NINOX Unattended Ground Sensor (UGS) project arose. The MUBASS has a great deal of interest by the Australian Federal Police and Customs department, and the United States, with the algorithm being provided to a number of overseas countries. MUBASS is able to compliment the current NINOX UGS project with little modification, and would provide a target acquisition capability for the RAA.

[25]Janes International Defence Review, August 1999, 8.

[26]Major Al Murtagh, Senior Instructor Locating, Royal School of Artillery, Larkhill, Salisbury, UK, October 1998.

[27]December 1999.

[28]Project NINOX Project Manager. 1999.

[29]These systems are expected to be in service by 2001.

[30]The original trial of the RASIT-B radars were conducted in 1983 by 131st Locating Battery. When the equipment entered service in 1985, the equipment was then transferred to the Intelligence Company, in an attempt to mirror the US Model of a Military Intelligence Battalion. The Intent of the purchase of the equipment was to develop doctrine and procedures for the eventual purchase of more equipment to outfit the remainder of the ADF with a surveillance capability. CTN1-4 is the only published doctrine on the employment of the radar, and is limited to generic deployment factors and equipment drills. Neither surveillance specific deployment doctrine, nor procedures of employment of the equipment have been developed. In 1995 when the radars were incorporated into the RISTA trial, the radars were returned to 131st Locating Battery, where upon TTP's were developed for the employment of the equipment.

[31]At the time of the A21 trial, 6 RAR was provided with two AN/TPQ 36 radars as part of the fire support company. Two more AN/TPQ 36 were notionally deployed to 5/7 RAR, whilst one remained committed to the high readiness Brigade. Had both 1 Bde and 3 Bde been equipped with the A21 trial structure, this would have required the purchase of an additional eight systems, with the three remaining AN/TPQ 36 systems at 131 Locating Battery used to support 7 Task Force and the remainder of the division.

[32]Forward Observers and Battery Commanders Parties were deployed on OPERATION SOLACE, but they deployed as civil affairs and liaison officers. No artillery weapons, sensors or other equipment were deployed to the country.

[33]In 1994, the Locating artillery section, at the doctrine and development wing of the School of Artillery, conducted an analysis of a video taped conference between US Fort Sill and the deployed US Artillery forces for OPERATION RESTORE HOPE. These observations are the result of that analysis. The analysis was published by the School of Artillery, from the AN/TPQ 36-user group established between the School of Artillery and 131st Locating Battery.

[34]These four radars are based upon the required for coverage of 2 RAR, 5/7 RAR and 3 RAR, each with two radars each. This requirement should be 6 radars, but due to the battalions operating over smaller areas than in northern Australia and allowing for a small degree of risk, this capability could be reduce to four systems. This would however not provided any support to mobile operations or units such as 2 Cav Regiment.

[35]Three systems at 131 Locating Battery and one system from the school of Artillery. These four systems were operational in the Land Army during the Army 21 trials, with two systems at 6 RAR and two systems at 131 Locating Battery.

[36]131 Locating Battery Standard Operating Procedures, dated 15 Jan 1999.

[37]These figures are based upon a 18-gun regiment deployed as 6-gun section, each section of three guns. Each gun section is greater than 30 kilometers apart and is unable to pass meteorological corrections. The registration missions would occur at 0400, 0600, 0800, 1000, 1400, 1600, 1800, 2000 daily. These timings are based upon the requirements to take into account the diurnal changes that occur in the morning and afternoon in northern Australia, and are in accordance with 131st Locating Battery standard operating procedure for meteorological message production, in support of a field regiment.

[38]These figures are based upon each registration mission only firing HE (no adjustment of height of burst for Mechanical Time), each mission consuming a total of 6 rounds at approximately $400.00 per round. (6 x $400.00 = $2400.00 x 48 mission = $115,200.00)

[39]This is an approximate estimation of the cost of a new MARWIN MW 12, based upon discussion with the Bureau of Meteorology, Melbourne and Viasala the manufacturer of the MARWIN systems.

CHAPTER 4

THE NEED FOR CHANGE

If the twenty-first century is to be characterized by increasing technology and improving information collection and processing, then the twenty-first century for most modern Western militaries began over ten years ago with the fall of the Berlin Wall in 1989. This single revolutionary event is often looked upon as the beginning of a new era in military technology, having a profound effect on militaries all around the world and forcing countries to rethink their now obsolete military plans and structures. This one event may be the true catalyst of the modern Revolution in Military Affairs (RMA), as countries now restricted by modest defense budgets and force downsizing seek the solution to achieving decisive victory without the ability to concentrate large forces.

Most Cold War plans emphasized massing forces over a short period. The global uncertainty that followed the collapse of the Berlin Wall made the previous plans unsustainable in a battlefield that was increasingly using precision and surveillance devices to find and destroy forces. A paradigm shift away from massing force to massing effects was required.

The end of the Cold War has led to the decreasing threat of a large scale conventional or nuclear confrontation between the superpowers, making the justification for large military budgets more difficult. "During the Cold War, and in the era of imperial defense which preceded it, Australia's strategic interests were closely bound up with a global balance of power. That is no longer the case" (Strategic Review 1997, 2.7). The emergence of failed states and rogue nations has, however, maintained a level

of uncertainty, especially in the Asia Pacific region. Regardless of this increased instability, the requirement to see benefits from the "peace dividend" resulted in large-scale downsizings of many militaries in the world, including Australia. By the end of 2002 the ADF will be approximately one half its peak pre-Cold War size.[1] This downward trend has been temporarily halted whilst the Australian Defense Force (ADF) raises additional units to meet the requirements for the peacekeeping operation in East Timor. Future warfare will be characterized by greater dispersion and precision, which will place a strain on the current size of the ADF.

The reduction in the size of the ADF forced military doctrine writers to rediscover the art and science of warfare and emerge from the linear stagnation adopted over the past 50 years. This rediscovery of classical military theorists, such as Clausewitz and Jomini, plus the acceptance of new theorists, such as John Warden concerning airpower and John Boyd concerning the Boyd Cycle and his analysis of operational tempo, permitted the revitalization of maneuver warfare in doctrine and training establishments. This has been especially true for the US Marine Corps, and is being slowly adopted by the ADF.

Strategic Review 1997

Changes in the ADF Strategic Guidance with the Strategic Review 1997 (SR97) have provided the ADF with a better focus to be able to anticipate the variety of missions which it is being called upon to provide. SR 97 will allow the ADF to embrace the notion of maneuver throughout the battlespace and throughout the region in which we anticipate becoming engaged. Additionally the recently published (1998) Fundamentals

of Land Warfare further refines National Security Strategies laid down in SR97 into definable military strategies.[2]

Australia Strategic Policy 1997 reflected a more outward looking policy that integrated all elements of defense and foreign policy. The focus for the defense force changed from defense of the continent to greater maritime defense focusing on the approaches to Australia. "Most ASEAN countries, for example, have made steady progress over the last decade in converting their militaries from largely ground-based forces - designed for counter-insurgency and internal security operations--to more balanced, conventional forces, typically with increased emphasis on the ability to monitor and protect offshore resources and interests" (Strategic Review 1997, 2.35). Australia must have the military capability to prevent an enemy from attacking successfully in its maritime approaches, gaining a foothold on its territory or extracting political concessions through the use of military force (Strategic Review 1997, 4.6).
The changes brought about by SR97 involve contributing to joint and coalition maneuver operations in a littoral environment (Strategic Review 1997, 5.30), and contributing to coalition operations when required. This policy infers that future warfare will be joint and coalition in nature.

The reemphasis of maneuver warfare has made most Western militaries realize that the former Cold War strategy, emphasizing massed forces, is no longer applicable nor tolerated by a public which has been educated by the media about the increasing levels of precision available. A shift in emphasis has been recognized as necessary to emphasize massing effects, not forces, the latter being characteristic of the Cold War, especially in the Western European context. Additionally Strategic Review 97 requires

the single service approach to maneuver to be reduced, with the requirement for all future operations to be either joint or coalition in nature (Strategic Review 97 1997, 5.30). The ADF does not have the force size required to conduct operations without the assistance of the other services, and if it is to contribute to coalition operations, then the importance of interaction with coalition partners is paramount.

The constant military reviews and downsizing seen throughout most Western militaries have been a direct result of the change in the strategic environment now faced by the respective countries. Tight fiscal restraint imposed during the world recession in the early 1990s has also forced countries to reevaluate the direction in which they want their militaries to head.

Armies that emphasize massing forces are costly to equip, train, and sustain. Technology is allowing once large forces, such as the US military, to disperse while still emphasizing the massing of effects through long range precision fires and digitization. The US military has been able to reduce the number of forces required and yet still achieve decisive results in operations such as Desert Storm and Kosovo.

Challenges for the RAA

The Australian Army viewed the technological evolution, which the world witnessed through CNN during the 1991 Gulf War, Operation Desert Fox and recently Kosovo, from the sideline. Whilst the main emphasis for the operations was the terminal effects of air delivered munitions, it showed the advancements that have occurred in precision weapons over the last twenty years. The West demonstrated that during the ground phase of the 1991 Gulf War, precision weapons, improved conventional munitions and high tempo operations, facilitated by good communication and digitization

networks, permitted emerging Information Age armies to overcome a physically and psychologically entrenched Iraqi Industrial Age military.

Changing technological advancement in the field of firepower and precision systems, and the increasing ability for countries to purchases systems "off the shelf" will mean that the ADF will no longer enjoy a technological advantage over its rivals. This diminishing technological edge will need to be replaced by a capability edge. This capability edge for the RAA will be attained through a paradigm shift moving out of the Industrial Age firepower that characterizes the RAA into the Information Age.

Industrial Age Firepower

Industrial Age systems are platform-centric. The focus of Industrial Age firepower is on delivery platforms being organized and deployed in fixed structures. They are commanded centrally, and observers who are organic to the firing unit most often control their fire.

Industrial Age firepower creates effects by concentrating the maximum number of available platforms against a target and continuing to deliver munitions until the aim is achieved. The lack of diverse, widely deployed and effective sensors and shooters often sees engagements initiated too late against fleeting targets, due to the requirement to adjust indiscriminate observed fires. Industrial Age firepower lacks precision, resulting in too much warning time being afforded the enemy against stationary targets. A lack of sufficient accuracy in target location against both observed and unobserved targets is characteristic of Industrial Age firepower, due to inherent inaccuracies in the system and the emphasis towards mass and attrition instead of precision and accuracy. Destruction is

difficult to achieve without a disproportionate expenditure of ammunition or the close direct application of firepower, which again increases the vulnerability of the platform.

The artillery delivery system is by design imprecise, logistically heavy and vulnerable to air and ground attack. Artillery was originally developed to cover an area that would allow dismounted infantry to assault an area and neutralize or destroy armed resistance that would interfere with securing the objective or target. The area weapon concept has been used to advantage in the past, permitting the systems to cover a large area. Changing battlespace geometry and the move away from terrain as an important tactical objective (characteristic of attrition warfare) will, however, limit the RAA's ability to cover large areas with indiscriminate effects to a small threat spectrum. This will limit the employment of the RAA delivery system in military support operations (MSO).[3] Factors such as collateral damage, which includes civilian casualties and cost, will determine where and when artillery delivery systems can be employed.

Due to the changing nature of warfare, the RAA delivery system is seen to lack versatility in scenarios other than warfighting, delivering only indiscriminate area munitions through the 105mm and 155mm systems. A precision system does exist with the M198 155mm howitzer using the Copperhead CLGP. Indiscriminate "dumb" projectiles reduce the flexibility provided to the commander in non-warfighting roles, where the concern for collateral damage and the reduction of civilian casualties is paramount.

It must be stressed that artillery is often seen as one of the most flexible of all combat arms due to the ability to shift fires at a moment's notice across the battlefield, whilst retaining command and control of the delivery systems, affording the commander

a high degree of flexibility to weight his main effort. Unfortunately, the systems that emphasize mass and attrition are at odds with the modern requirement for accurate and discriminate engagements.

Future Land Warfare 2030 (FLW 2030) was written to "guide doctrine through the likely trends over the next 30 years, and seeks to provide the broad direction for the Army's concept led, capability based approach to land force modernization, which was first articulated in Land Warfare Doctrine 1: The Fundamentals of Land Warfare" (FLW 2030 1999, i). FLW 2030 states that the modern battlefield is expected to become increasingly urbanized, with the ADF emphasizing the "capability oriented toward warfighting against a variety of international actors, as this will continue to be the most demanding task to land forces. Australia's geostrategic circumstances and regional demographic trends highlight the need for land forces to maintain an expeditionary focus with a rapid deployment capability, particularly into a littoral environment that is becoming increasingly urbanized" (FLW 2030 2000, Chapter 2, 10). This will increase the likelihood of conflict within the littoral area, and, therefore, the engagement of potential targets in a more urbanized area, increasing the requirements for precision and discrimination from the delivery and ammunition systems.

A Paradigm Shift: Information Age Firepower

Information Age firepower is network-centric and focuses on effects management, not platform management, allowing commanders to concentrate effects rather than massing forces to achieve their aims. Advances in communications and long-range munitions systems have enabled this. The result is a more widely distributed capability where previously nontraditional organizations or units are able to access forces

which were previously guarded by a hierarchical command structure. The result is a greatly improved tempo of operations with the emphasis placed on the effect required at the target location instead of the management of the delivery systems to achieve the endstate.

A study conducted in 1999 by the Land Development Branch Capability Systems Division, "Concept for the Employment of Firepower to Support Future Land Force Operations,"[4] has concluded that some characteristics of the AAN information based firepower capability are:

1. Instead of fixed inflexible structures, firepower assets must be tailored for force projection before deployment or during mission staging in a more versatile and dynamic manner. These firepower strike forces will also manage and apply a wider range of effects in a more versatile manner. Effects must be managed to rapidly, effectively and efficiently overmatch the target, rather than be based on the relative position of the delivery system and the target acquisition system or on outdated command and control considerations.

2. The responsibility to move, position, fire and sustain delivery platforms is separate from the responsibility to coordinate the effects delivered by the platform. Separate and distinct effects coordination centers (probably fewer than in the current force) must be established to better fuse the command decision-sensor-actor linkages and better support the targeting process of 'decide, detect, deliver and assess'.

3. The sensor-to-actor[5] links being perfected today will be expanded significantly, linking a much broader range of joint (and combined and multinational) sensors, in real or near-real time, to an equally expanded range of on-demand effects

through the effects coordination centers. These centers will be able to establish, alter and terminate direct sensor-to-actor links in seconds without lengthy coordination or reconfiguration.

4. Platform-centric approaches will give way to a focus on effects research and development. Focus will move from the caliber, accuracy and precision of the delivery platform to munitions that have increased range, loitering time and lethality; that offer more versatile terminal effects; and that perform their own battle damage assessment.

Bridging the Paradigm

The RAA firepower capability is made up of a series of related component systems that can be listed as the decision systems, effects systems, sensor systems and supporting systems.

The Decision Systems. Command, control, communications, computers and intelligence (C4I) systems, include the network centric warfare (NCW) aspects of sensor to shooter links. "Network-centric warfare" is the term used to describe the effective integration of sensor systems, command support systems and weapons systems throughout the battlespace. (LWD 1 1998, 4-15) NCW provides the means for a relatively small, high technology force to achieve disproportionately greater effects than has been previously possible through this integration (LWD 1 1998, 4-17). NCW enables the harnessing of the capabilities of a number of disparate systems to work together to achieve a common effect. NCW is expected to have the same effect in the Information Age armies, as the use of combined arms had in the later stages of World War 1 and World War 2 for the Industrial Age armies. NCW requires high levels of interoperability

among the ADF's disparate combat systems and allies to ensure that systems are compatible.

The Effects System. The effects system refers to the ammunition and the delivery system which combine to produce the effects required. This system has the capacity to provide a significant technological edge to any regional power that invests in high quality munitions. It will be important for the ADF to maintain close parity with regional acquisitions in effects systems technology so that, in conjunction with the other elements of the capability, a capability edge can be maintained.

Sensor Systems. Sensor Systems include the surveillance and target acquisition (STA) capabilities of observers and electronic devices, such as radars, acoustic sensors, UAVs, and satellite systems.

Support Systems. Sensor Systems include survey, meteorology, calibration and artillery specific logistics.

These four factors will be referred to as DESS (Deciders, Effects, Sensors and Supporters). The combination of the C4I and technological developments in the future STA systems (C4ISTAR) offers the greatest opportunity for the ADF to develop a significant capability edge over any potential aggressor. An effective C4ISTAR system will:

1. Ensure the characteristics of the various STAR elements are effectively aligned with the characteristics of the delivery and effects systems and the likely target arrays.

2. Underpin the move to real and near-real time linkages between command decision sensor and actor networks.

3. Allow focused and versatile effects management across a broadening array of sensors and actors.

4. Allow this network-centric approach, once it is in place, to upgrade or replace capabilities at its nodes and, in doing so, continuously enhance its overall performance.

System of Systems

When considering the RAA firepower capability it is vital that all aspects of DESS are considered. Any replacement, enhancement or removal of one of these systems will have a profound impact on the other components. For this reason, they must not be considered in isolation.

At present no new weapon system is due to replace the current fleet of 155-millimeter M198 and 105-millimeter L118/119 towed howitzer weapons systems until 2010. No mention is made in the acquisition forecasts[6] of the requirement to review the other artillery systems, such as target acquisition systems, or supporters, such as survey[7] and meteorology.

The ADF is currently investigating the fielding of equipment under the Battlefield Command Support Systems (BCSS) architecture to address the deficiency in the artillery C4I systems. Due to funding, however, this will not be fielded to the RAA before 2002 and then only at brigade level (BCSS project manager, 27 August 1999). The lack of a BCSS systems at the platform level (per delivery or target acquisition systems) will still require the delivery systems to physically mass prior to the engagement of targets. This is due to the nature of the ballistic computation process and the lack of communication systems. A BCSS system at the platform level would enable the benefits of digitization

to be achieved. Changes in ammunition systems and observation protocols (doctrine) will then be required to capitalize on the BCSS system.

Limitations of Current Force Development Process

The Joint Services Committee for Foreign Affairs Defense and Trade has concluded that typically it takes a decade to identify the need for, and introduce into service, a major system platform.[8] Development of professional mastery in the operation of a major platform may take even longer. Some major equipment fleets have a life extending to 40 years.[9] "Consequently, the Army requires the capacity to identify its major capability requirements well in advance. The ADF also requires adaptive and flexible capabilities able to be employed for an extended period" (JSCDFAT Submission 1999, 25).

The importance of highlighting the requirement for a systems approach is to ensure that the replacement artillery capability is viewed as a capability and not as an equipment replacement program. The AAN concept stresses capabilities, and not equipment or structures, as central to the way armies will fight in the future (LWD 1 1998, 18). Any future artillery capability will need to be expressed in these terms, with an emphasis toward the desired effects and not the delivery means required. Only through this change in emphasis, facilitated by a change in doctrine and training, will future capabilities be able to support the maneuver concept of warfare and the AAN.

Conclusion

Strategically the end of the Cold War had little impact on the environment which the ADF has operated in, especially over the past thirty years. However, the lack of a perceived threat to the Australian mainland from conventional forces and the limited

warfare roles which typified the Army's role in Defense White Papers of 1987 and 1994 resulted in little technological evolution in the way the ADF conducted warfare. This lack of a perceived threat has resulted in very little modification to the way the RAA conducts effects management, maintaining an Industrial Age capability. The geographical isolation to threat overseas and the focus on the defense of Australia has resulted in very little evolution by the Army in the areas of precision weapons and information warfare.

The RAA must view the indirect fire capability as a system of systems, embracing capabilities and not equipment. The previous long lead time development and acquisition process has maintained an equipment replacement policy instead of a continual capability enhancement program.

Strategic Review 1997 and the Future Land Warfare Document indicate the direction the ADF and the Army is moving, emphasizing network-centric warfare, precision, effects management and a move into the Information Age. The RAA will need to adapt to the challenges to meet the requirements of the AAN to ensure the future indirect firepower capability, consisting of a system of systems, can be used throughout the entire spectrum of conflict.

---

[1]The ADF was approximately 46000 personnel during the early 1970s. As of May 1999, the strength of the Australian Regular Army was 23,380. This comprised the fully trained force of 21,944 personnel with the remainder 1,886 undergoing training. The post-defense reform program target strength is 23 000. (JSCFADT Inquiry, 1999)

[2]See LWD 1 Fundamental of Land warfare, 1998, p 3-18 for an explanation of the Military strategies that the ADF is expected to adopt due to the SR97.

[3]Military support operations includes Peace operations and Support Operations. Example of Peace Operations include: Peacekeeping and Peace-enforcement. Examples

of Support Operations include Defense Force Aid to the Civil Community (DACC) and Defense Force Aid to Civil Defense (DFACD). See Fundamental of Land Warfare 1997, Annex B for a complete explanation.

[4]The concept for the employment of firepower to support future land operations document as that the first of January 2000 was still in draft. It highlights the requirement to look at the artillery capability as a system of systems and move from the industrial to the information age firepower.

[5]In the past this term has been referred to Sensor-to-Shooter. It has been changed here to reduce the implication that the target effect will always be achieved through some from of Kinetic targeting using a weapon delivery system. The term actor is used throughout to provide the implication of both lethal and non-lethal force being used and coordinated to achieve the optimum effect.

[6]Defense New Major Capital Equipment Proposals 1998-2003, and the Department of Defense White Book 1998-99.

[7]The survey replacement program is referred to as the Artillery Orienting System (AOS). This is currently in the process of replacement but is not mentioned in the Defense New Major Capital Equipment Proposals 1998--2003, and the Department of Defense White Book 1998-99, due to the small cost of the project.

[8]The Australian Army Submission to the Joint Standing Committee on Foreign Affairs Defense and Trade, page 25.

[9]Ibid.,21.

CHAPTER 5

EMERGING TRENDS IN TECHNOLOGY RELATED TO DECIDERS, EFFECTS, SENSORS, AND SUPPORTERS

This chapter will outline some of the emerging technological trends which are expected to become commonplace in the AAN. The analysis consists of a detailed review from open sources of the past five years of technological development relating to DESS systems. In the past such reviews have focused on a country's capabilities in an attempt to equate equipment quantity with capability. A good example of this is the analysis of Saddam Hussein prior to the 1991 Gulf War. Saddam Hussein had thousands of tanks and artillery pieces, but without leadership, C2 and training this equipment was no more than a series of individual pieces of equipment. Whilst some Asia Pacific country capabilities will be briefly discussed, this is not necessarily relevant, due to the proliferation of technology and the increasing ability to acquire systems "off the shelf". Hence, countries can purchase systems quickly and, over time, develop them into capabilities. The result is that Australia will no longer enjoy a level of technological advantage over its regional neighbors; as Australia moves closer to 2030, it will be indistinguishable from other counties in the region based upon technological equipment.

The shift for the ADF from technological superiority to technological parity within the region increases the importance of the requirement to ensure that complete systems are integrated. Countries will be able to purchase high technology equipment, but the capability will be realized through the synergy of the sum of the parts, not individual components.

Deciders

The analysis of decider systems available off the shelf is extensive and beyond the scope of this thesis. Decider systems are increasing rapidly and interest in them is not limited to only Information Age armies, such as the US, UK etc. These systems are being developed by a large number of countries. The ADF's contribution to this capability is the introduction, in part, of the BCSS capability, which is to provide a command support system down to company or squadron headquarters level in both mounted and dismounted roles. For artillery units BCSS will be provided down to battery command posts, unit headquarters, brigade and battery JOSCCs and JOSTs. The BCSS systems is expected to commence equipping the 3rd Brigade Ready Deployment Force in fiscal year 2000-2001. Whilst any credible analysis of this capability will need to be conducted once the system is in place, future indirect fire support systems will need to have digitization systems down to the platform level and not be limited to the command posts. Only then will the true benefits of digitization--the ability to disperse and maintain control, reduced reaction time from observation to effect, more efficient administration, and the ability to respond quickly to changing situations--be realized.

Effects

Ammunition

Whilst the Gulf War is not a good example from which to draw operational conclusions, it presents a good example of different artillery capabilities matched against one another. Iraqi artillery can be characterized as industrial based, emphasizing massed weapons and a rigid command and control system. The coalition artillery capabilities were those of precision, improved munitions, and employment of varying levels of sensor

to actor networks. In the book *Certain Victory: the U.S. Army in the Gulf War*, Robert H Scales Jr. stated:

> In a word, Saddam's artillerymen had simply failed to make the technological improvements in their artillery that have been available for 20 years. Surprising their Israeli opponents Egyptians dramatically demonstrated the precision guided munitions revolution in the opening tank and anti-tank missile engagement in the October 1973 war. The precision revolution progressed more slowly to indirect fire because to hit an unseen target the first round required refinements in the ability to locate both the target and the fire position, as well as the ability to predict very accurately the ballistic course of a projectile. Ballistic refinements arrived with the development of digital fire control computers, precise weather measuring devices, and devices to measure the velocity of a projectile in-flight. Target acquisition radars, laser range finders, and the now indispensable GPS allowed a similar precision in locating targets and fire positions. If all of the parts are assembled and employed properly, the radius of their "dumb" artillery projectile is easy cut in half. DPICM or bomblet artillery munitions, in turn, have almost tripled the lethal radius for artillery. This quantum jump in precision and lethality meant that for the first-time in history the artillery kill radius was greater than its radius of error. In other words, if American artillery shot at an Iraqi position, it died. Iraqi artillery, on the other hand, possessed long-range but little else. They had failed to invest in the technology necessary to achieve a first round kill, learning the hard way that range without precision is no advantage at all. (Certain Victory: The US Army in the Gulf War, reproduced with permission in CGSC C300, Lesson 1, Jun 99.)

Whilst it would be unfair to draw a parallel between Iraqi and RAA artillery, the RAA could use the Gulf War as a litmus test for the level of support it believes it will need to provide to the AAN.

Within recent conflicts, such as Somalia, Bosnia, and Kosovo, artillery has continued to demonstrate its potential as a major player in the combat power trilogy.[1] However, apart from the Gulf War, there have been few opportunities to deploy artillery on operations, and when deployed there has been little operational use of the much publicized smart artillery projectiles. An analysis of these operations would find few

instances where the availability of such smart munitions added to the attainment of the operational objectives. Had ground forces, however, been deployed in Kosovo, the utility of precise munitions and sensor-fused munitions, it can be assumed, would have aided considerably in the destruction of armored vehicles and personnel. The unwillingness to deploy ground forces or the lack of their employment in peacekeeping operations does not mean that smart munitions will not play a large part in any future conflict. This simply highlights a range of munitions that still must be available to commanders for future operations.

The entire ADF, including the RAA, was a victim of the developmental void that appeared in the early 1960s. Whilst the US Army was involved in Vietnam, it was also involved in the Cold War against the Former Soviet Union in Europe. Any active involvement that the ADF had in the Cold War was purely political. The ADF was concerned about curtailing the spread of communism in Malaya and Indonesia and the Vietnam War. "During the Cold War, Australian defense planners paid comparatively little attention to Western ideas about conventional deterrence. This was largely because the use of conventional forces to deter aggression was seen through the narrow lens of superpower confrontation in Europe and in the context of nuclear deterrence theory. Both of these propositions were often difficult to apply to Australia's strategic conditions." (Evans 1999, 1) The requirement to develop smart projectiles was costly, and the operational imperative less for the ADF, as it was only concerned about operations at the tactical level during operations in Southeast Asia. Additionally the Australian defense industry lacked the technological capability at that time to produce smart weapons.

Smart Munitions

The Central European battlefield drove research and development by the US, UK and other European countries towards concentrating on developing high terminal accuracy field artillery rounds. This research and development focused on the main problems of engaging armored vehicles, in particular main battle tanks, because of the Soviet threat in Western Europe. The main outcome of this research and development was a semi-active laser homing projectile, the "Copperhead," and later towards the end of the 1980s and early 1990s a sensor fused submunition, SADARM (Seek and Destroy Armour) (Verlagsgesellschaft, Military Technology 1998, October edition).

These two projectiles represent the main types of precision guided artillery projectiles. Copperhead is a laser-designated munition requiring an observer to illuminate the target with a laser designator. SADARM uses a semi active laser homing system which, once dispersed above the target area, selects and destroy targets automatically. It is interesting to note that, outside the U S Army, no other Western country has adopted Copperhead as its preferred precision munition. Outside of Australia, only Jordan and South Korea are known to have purchased the Copperhead. (Janes Armor and Artillery 1998/99, 299) Western armies expressed their preference for sensor fused submunitions such as SADARM (USA), Smart 155 (Germany) and BONUS (France/Sweden), which are all based on the same principles and working mechanisms. (Verlagsgesellschaft, Military Technology, 1998 October edition).

Copperhead is limited by a number of factors, including the angle between the observer, the target and the delivery system; inability to acquire targets with low cloud cover (a common occurrence in Western Europe); the cost per projectile of U.S. $40,000,

and the absolute dependence on the presence of a forward artillery observer and designator. Given the speed of an expected Soviet advance in Western Europe during the Cold War, the life expectancy of a forward artillery observer and his ability to designate Copperhead projectiles was low. The advantage of Copperhead is hat it offers the capability to engage almost any stationery or slow moving target, where sensor fused munitions are inflexible, and "optimized for the single specific purpose of engaging armored vehicles and completely useless for any other fire mission" (Verlagsgesellschaft, Military Technology, 1998, October edition).

With the world's urban population growing at four times the rate of the rural population, it is expected that by 2025 the number of people living in urban areas will double to more than 5 billion, representing 66 percent of the world's population. (FLW 2030 2000, 2:3) This increases the likelihood of future operations occurring in urbanized terrain. Recent examples of such operations include Somalia, Bosnia, Kosovo, Panama, Haiti, and East Timor. Therefore the artillery in peace support operations will require a precision capability to engage clearly identified targets whilst minimizing the risk of collateral damage. Currently the only means that the ADF and most Western countries have to achieve this is through precision guided munitions (PGM) either artillery or aircraft delivered. Under these circumstances, a human operator to positively identify targets in accordance with the rules of engagement is vital to mission success.

Precision Guided Munitions and Complex Terrain

The use of PGM will become increasingly important in the ADF's expected role in the littoral warfare. However, cannon delivered PGMs rely upon a ballistics trajectory which often cannot be employed in urban terrain, where buildings may interrupt the

trajectory prior to the target. What is needed is an ammunition system that can have a near vertical attack profile and still engage the target with precision. Larger caliber mortars, such as 120-millimeter caliber, offer a significant advantage over the use of the flat trajectory 105-millimeter and 155-millimeter ammunition. The suite of 120-millimeter mortar systems offers a greater range than a 105-millimeter L119 system, and offers a much broader range of precision ammunition options to provide the best attack profile for complex terrain, such as urban environments.

No doubt the future will see more munitions, such as BONUS, SADARM, smart 155-millimeter and the Russian 122 millimeter Universal Smart Munition, that can seek out their own targets and destroy them (Terry J. Gander and Charles Q. Cutshaw 1999, 583). Costs will, however, prohibit the inclusion of these systems in the ADF inventory. A more cost effective precise system similar to Copperhead and the inclusion of GPS guided projectiles will best suite the AAN requirements.

155-millimeter Ammunition

One of the most important developments in artillery effects has been the US XM982 155-millimeter projectile. The XM982 incorporates three potential payloads; 64 DPICM bomblets, 2 x SADARM sub-munitions and a unitary round capable of penetrating protective structures. The projectile has a target accuracy of 20 meters at its maximum range of 57,000 meters. The projectile uses a GPS guidance fuse for trajectory monitoring and corrections. (Terry J. Gander and Charles Q. Cutshaw 1999, 17) The projectile is able to achieve this range using a conventional propellant and without the need for base bleed or rocket assisted devices. The projectile uses fins for course corrections, which permits the projectile to glide to the target. (Terry J. Gander and

Charles Q. Cutshaw 1999, 297) The projectile also includes anti-jamming capabilities with the inclusion of an inertial measuring unit, keeping the projectile on the last known heading. Whilst the 57,000 meter range is expected to be achieved from the 52-Caliber US 155-millimeter Crusader delivery system, the projectile is expected to achieve 40,000 meters from the M109 series of self propelled howitzers and towed 39-Caliber howitzers such as the ADF's 155-millimeter M198 (Terry J. Gander and Charles Q. Cutshaw 1999, 298).

Prior to the development of the XM982, the only way to increase range was to use an extended range projectile incorporating some form of rocket assisted or base bleeding supplementation. The only advantage these projectiles offered was an increase in range. However, as demonstrated in Iraq, range without precision does not provide a capability. Therefore the XM982 maybe a revolutionary projectile, not only because it provides longer range and high precision, but it will also force a reevaluation of how artillery is force packaged and what constitutes the fire support unit's mission. The emphasis can now potentially move away from area coverage emphasizing high volumes of ammunition usage to precise targeting with a number of individual aim points per target area. This will reduce ammunition expenditure and increase the potential for artillery systems to support more units due to the frequency with which the unit will be able to "fire and forget." This will aid the incorporation of the network centric warfare concept as described in LWD 1.

Table 3 provides insight into the trend that is emerging in ammunition development for cannon artillery. The trend is for the development of 155-millimeter systems incorporating precision systems with longer range.

Table 3. The current status of some of the worlds modern artillery ammunition and their guidance systems.

Ammunition Type	Country	Type	Status
122mm Kitolov-2M	Russia	Laser-guided	Prototype
152mm Krasnopol	Russia	Laser-guided	In Production
155mm Krasnopol-M	Russia	Laser-guided	In Development
155mm Copperhead	USA	Laser-guided	Production Complete
155mm XM982	USA	GPS-guided	In Development
155mm SADARM	USA	Smart	In production
155mm BONUS	France/Sweden	Smart	In final trials
155mm SMArt 155	Germany	Smart	In production
155mm VLAP	South Africa	Long-range	In final trials

Source: Foss, *Janes Defence Weekly,* 31, No 7, 17 Feb 1999.

For the future indirect firepower system, the notion of what constitutes its mission statement in support of tasks such as neutralization and destruction must be rethought as projectiles become more precise. Projectiles, such as the XM982, will provide the ADF the means to move away from massing forces in order to mass effects and permit individual delivery systems to achieve what was once considered a complete fire unit mission. It is interesting to note that one of the key selling points of the US Crusader system is that, due to the high rates of fire achieved through improvements in

ammunition technology and automatic handling systems, two Crusader guns can equal the firepower of an entire M109 self propelled howitzer battery[2].

Other projectiles that have recently been developed include the South African velocity enhanced artillery projectile (VLAP), which features both rocket assisted and base bleed functions. When fired from a 155 millimeter/45-caliber barrel, their range is 52,500 meters (Janes Defense Weekly, Volume 31, Issue 07, February 17, 1999). The UK is expected to start using a GPS course correction 155-millimeter projectile in 2005. (Janes International Defense Review, December 1999, 14) Micro-electromechanical systems provide the means for inertial guidance systems inside artillery mortar and missile warheads (Janes Defense Weekly 20 October 1999). And China has begun production of the Russian designed Krasnopol 152 millimeter PGM. The technology to produce this munition has been transferred over the past two years from Russia to China. The technology to produce this projectile has also been sent to India, with its recent purchase of 1,000 projectiles and 10 laser designators. (Janes Defense Weekly, Volume 32, Issue 16, 20 Oct 1999) The Indian version of this projectile is the 155-millimeter system, the Krasnopol-M. Whilst both these countries are expected to have a large domestic consumption for training and operational purposes, the possibility exist that these systems will soon find their way into the inventories of more regional countries, further eroding the perception the ADF has of regional technological superiority.

<u>105-millimeter Ammunition</u>

The Royal Ordinance ammunition factory in the UK has extended the range of the 105 millimeter system with the HE ERM1, which increases the range of the 37 caliber L118 from 17.2km to around 20.6 km.(Janes International Defense Review, Volume32,

January 1999) The HE ERM1 has a greater range, muzzle velocity and is more lethal then the old HE M1. This improved 105-millimeter M1 projectile increases the present ADF ammunition systems by 64 percent and can be used with the L119 Light Gun. (Janes Defense Weekly 15 September 1999 page 74) This projectile, coupled with the UK course corrected fuse, can be fit to a standard 105-millimeter artillery projectile, (Janes Defense Weekly, Volume 31, Issue 11, 17 March 1999) and can offer the ADF a substantial improvement in capability for the AAN, but still within the time frame of the Enhanced Combat Force, simply through an ammunition purchase.

The ADF will need to consider if the traditional 105-millimeter light artillery is still applicable to emerging future environments, and if the AAN's fire support system could be better served from an alternative delivery system. On the other hand, a combination of 105-millimeter and 120-millimeter systems within the one unit may offer the advantage of both systems and provide the capability or force packaging to meet a variety of contingencies within the littoral environment. 120-millimeter mortar ammunition continues to improve in range and payload options. If the ADF is to continue with the current M1 ammunition for the L119, the feasibility of replacing the 105-millimeter light gun with a 120-millimeter mortar should be reviewed. The role of the 81-millimeter infantry mortar must also be evaluated as to its effectiveness in supporting infantry operations in the future. If artillery must be precise and discriminate to support the AAN, then so must the infantry mortar system. The 120-millimeter mortar systems can be precise and use improved conventional munitions. The potential exists for a gun battery to consist of a number of 105-millimeter guns for longer range fires (assuming the M1 system is replaced) and a number of 120-millimeter mortars in the

same unit for precision fires in urban or complex terrain. This type of unit would provide the commander an increased degree of flexibility and capability not only for warfighting operations but also for military support operations if required.

Nonlethal Effects

Nonstandard projectiles, such as illumination, may start to decline due to the widespread use of night vision devices. Smoke projectiles designed to defeat thermal sensors will be retained, due to the increase in thermal imaging systems throughout the world. Other projectiles, such as the South African 155-millimeter Radar Echo M1 projectile, designed to be fired over a target area to confuse or jam the radar systems, will increase in importance as the equilibrium between lethal and nonlethal effects are sought. Artillery delivered radio jamming systems, possibly incorporating GPS jamming, will also increase in significance.

Area versus Precise Effect Requirements

The issue facing the RAA to support the AAN is to define the requirements for area effects versus precise effects. The answer will lie in the middle ground with the development of more accurate and effective area munitions, whilst having the ability to engage high payoff point targets when needed and without any additional equipment or changes in procedures. The RAA's acquisition of the Copperhead capability must be used to inform the development process in the acquisition of precision indirect munitions for the AAN. Copperhead is the technology of the 1970s and should be used as an enabler to the development or procurement of the next precision effects systems for the future indirect fire support system.

The development of doctrine for the employment of PGMs and the inclusion of PGMs in tactical and operational planning is required. The RAA must not limit the development of new support concepts by the proverbial trench out of which we have failed to climb in the past. The RAA must look beyond the traditional forms of indirect fire support and embrace new technology and effects. The knowledge edge will be developed through the implementation of a complete effects system that employs both lethal and non-lethal systems and challenges the defense industry to produce new and innovative effects. All new artillery delivery systems will have longer barrels and ranges and employ very accurate munitions. The true revolutionary effect will be using these systems and synchronizing them with allied or coalition forces in a joint environment, using both lethal and nonlethal systems at all levels. What is clearly evident is the continued use of the U S M107 projectile by the ADF until 2010-2015 will clearly jeopardize the RAA's ability to realistically support the enhanced combat force and restrict the development of the technological framework to support the Army After Next.

Rocket Artillery Ammunition

It would be remiss to only consider tubed artillery projectiles when rocket munitions and delivery systems already exist in the Asia-Pacific region. Continued enhancements in rocket artillery focus on improvement in range and incorporation of more effective warheads. The standard rocket warhead is high explosive and DPICM. This is one area in which U S technology has been unable to compete with countries such as Russia, China and Brazil. All these countries actively export rocket systems which have ranges double that of the current U.S. MLRS.[3] This is also the area which the Former Soviet Union continued to emphasize after the 1973 Arab Israeli War. Whilst

Western countries concentrated on self-propelled artillery and better decision systems, Russia continued to develop and enhance its rocket artillery. The technology for these systems has now been exported to other countries, including China, Vietnam, Cambodia, Indonesia, Thailand and India within the region.

Rocket systems in the Asia-Pacific region have not caused large concern in the past, due to their range not exceeding that of conventional tubed artillery.[4] Any country to acquire a rocket artillery system with a significant range advantage when compared to current and emerging tubed projectiles would have a significant capability advantage over the ADF. The trends emerging for rocket artillery include course-corrected munitions, GPS guidance and the potential to include fuel air explosives as a warhead option. Conversely this is an area which the ADF would be able to exploit as a clear advantage in the region, should such a system be acquired.

Ammunition Propellant

The evolution in ammunition propellants has resulted in the development of a modular unique charge propellant system, which significantly reduces the logistics burden of bagged charge systems. Instead of a varied multi-charge system using cotton bags, the modular charge system reduces waste and provides a series of uniform charge modules which can be easily selected by computer and automatic loading systems. Whilst the modular charge system has "not necessarily improved ballistic performance it is a different way of handling solid propellant and has enabled improvements in automatic loading systems to enhance self propelled and towed artillery systems increasing their rates of fire." (Terry J. Gander and Charles Q. Cutshaw 1999, 583)

Delivery Systems

The trend that has emerged over the past five years in delivery systems encompasses significant enhancements in range developed by the introduction of increased gun barrel length. The latest generation of 155-millimeter delivery systems have 52-caliber barrels that can produce ranges with existing projectiles out to 40,000 meters, with 47,000 meters achievable with some enhance range projectiles. (Jane's Ammunition Handbook 1998-1999, 583). However, any further advancements in barrel length will be limited not by ballistics but by metallurgy and basic physics. Some form of muzzle reference system such as those used on tanks, may be needed in the future to compensate for barrel droop and longitudinal barrel stress.

The 155-millimeter 52-caliber ordinance is emerging as the standard medium caliber barrel on both self-propelled and towed systems. Examples of these include the U.S. Crusader, the German PzH 2000, the British Upgraded AS90, French CAESAR, and the Singaporean FH 2000. All of these systems are capable of achieving greatly enhanced ranges compared to the 39-caliber M198 using the M107 ammunition system.

Table 4 is a comparison between ranges of regional cannon and rocket artillery in the Asia Pacific region. It shows that the current indirect fire support systems is presently limited not only by the delivery systems but also, most importantly, by the ammunition system. The Singaporean FH2000 can achieve 24 kilometers with M107 ammunition, but the RAA could achieve 40 kilometers with the XM 982 ammunition with the same M198 as the present capability. This would provide the ADF an excellent bridging capability until future indirect firepower capability requirements can be determined, while still maintaining an effective indirect firepower capability for the AIB and the ECF.

Table 4. Current and emerging ammunition systems for tubed and rocket artillery.

Ammunition Type	Range (km)	Guidance Systems	Remarks
Cannon launched projectiles			
152mm Krasnopol	20	Laser-guided	Fired from 2S19, 90% kill probability
155mm Krasnopol-M	20	Laser-guided	
155mm Copperhead	**16**	**Laser-guided**	
155mm XM982	57	GPS-guided	52 Cal Crusader
155mm SADARM		Smart	
155mm BONUS	35	Smart	CAESAR 52 Cal.
155mm SMArt 155	28	Smart	PzH-2000 52 Cal.
155mm VLAP	50	Long-range	45 Caliber G5
155mm M107	**18.1**	**Conventional**	**M198, (Singapore FH2000 able to achieve 24km with M107 and 40 km with Extended range full bore base bleed ammunitions)**
155mm M549A1 RAP	30	Conventional	M198
120mm AMOS	13	Conventional	120mm SP Mortar
105mm L31 (L118)	17.2	Conventional	Abbott ammunition system
105mm ERHE (L118)	20.6	Conventional/ GPS	
105mm HERA (L119)	19.5	Conventional /GPS	Both HE and DPICM avail
105mm M1 (L119)	**11.5**	**Conventional**	
Rocket launched projectiles			
127mm SS30	30	Conventional	Brazil
180mm SS40	35	Conventional	Brazil
300mm SS60/SS80	60/90	Conventional	Brazil
227 mm MLRS	32	Conventional	USA
227 ER MLRS	39	Conventional	USA (incl HIMARS)
220mm URUGAN	40	Conventional	Russia
300mm SMERCH	70	Course Corrected	Russia
273mm WM80	80+	Conventional	China

Source: Gander and Cutshaw 1998-99.

The original manufacturers of the M198, Rock Island Arsenal in the US, have proposed an extended range improvement program to increase the range of the M198 without increasing the system's weight. This improvement will use technology and new metal alloys to replace the 39-caliber barrel with a 52-caliber version, improving the range to 30 kilometers with unassisted projectiles, 37.5 kilometers using the M549 rocket assisted projectile and 40 to 50 kilometers with future rocket assisted and base bleed systems (Foss 1998/99, 749). No country has yet expressed an interest in this upgrade path due to the already heavy M198 system and its lack of tactical mobility.

Any newer 155-millimeter systems for the ADF would have to capitalize on a lighter version to ensure the systems are more tactically mobile. However, a lighter version of the emerging 155-millimeter system, such as the Royal Ordinance 155-millimeter Light Towed Howitzer (LTH) and the Vickers Shipbuilding and Engineering 155-millimeter Ultra lightweight Field Howitzer (UFH), only has a conventional range of 24 kilometers and 30 kilometers using rocket assisted projectiles. This is due to these systems being limited to 39-caliber barrels to meet the weight restriction for airlift by the UH-70A Blackhawk. No significant advantage will be provided to the ADF should it upgrade to these systems in 2010. The true range advantage (assuming this is the effect that is desired, based upon the military strategy and capability requirements) can only be greatly increased through embracing a 52-caliber barrel, and, therefore, the full capability of emerging long-range ammunition systems.

This underlies the reason for the separation of the ammunition and delivery systems in the effects component of DESS. Often the effects are considered to be the delivery system, when clearly the delivery system is now a function of the ammunition

and not the other way around. The capability statement for the future RAA requirement to support the AAN must clearly articulate the range at which the effects are to take place and the scope of lethal and nonlethal effects. The selection of the delivery systems will follow from those requirements. The delivery system requirement should only be relevant to tactical mobility and crew performance. The aspect of range and effects is a function of the ammunition system.

A significant payoff for the ADF can be achieved well before the AAN by incorporating modern ammunition systems into existing legacy delivery systems. The M198 is capable of firing virtually all NATO 155mm projectiles, including the latest VLAP, SADARM and XM982. This will provide a cost effective capability enhancement with no capital equipment outlay.

Rapid advances in technology undermine the ideology of a platform-centric replacement policy. To delay the consideration of new ammunition systems until new light (105-millimeter L119) and medium (155-millimeter M198) delivery systems are considered (2010-2015) would have catastrophic consequences for the indirect fire support system. Again, this highlights the importance of establishing a strategy to view the RAA capability as a system of systems and focusing upon the effects required. Additionally, harvesting the intellectual efforts of the defense industry and the Defense Science and Technology Organization (DSTO) can help to overcome these issues.

Rocket systems have seen improvements in range, mainly in an effort by the West to match those of the Former Soviet Union. The US Army is looking at rocket systems to support the "initial brigade"[5] with high mobility artillery rocket systems (HIMARS) to offset the current light artillery and the poor strategic mobility of self-propelled artillery.

HIMARS is a lighter version of the US MLRS system with the same ammunition system and range performance. The UK Army also has a requirement for a lightweight rocket launcher for rapid deployable forces. The UK Staff Target (Land) 4095, calls for a lightweight mobile artillery system (LIMAWS), consisting of a 155-millimeter lightweight gun and a lightweight rocket launcher system to fire the current and future MLRS rockets. (Janes Defense Weekly Volume 31, Issue 7, 10 Feb 1999) The British plan for the 155-millimeter lightweight howitzer is to replace all 105-millimeter systems in service by 2006 (Janes Armor and Artillery 1998/99, p 739), which includes units such as the air assault brigade and the commando brigade in the Royal Marines. The UK is also considering a fiber-optic guided missile system to give precise accuracy out to 60 kilometers. (Janes Defense Weekly, Volume 31, Issue 7, 10 Feb 1999)

Sensors

Unmanned Aerial Vehicles

One of the single most important developments in sensors over the past twelve months has been in the area of unmanned aerial vehicles (UAVs). The Kosovo air campaign saw the deployment of UAVs by the U S, British, French, and German defense forces (Janes Defense Weekly, Volume 32, Issue 26, 30 Jun 1999, 10). Kosovo highlighted the deficiency in tactical acquisition systems employed by the U S Army. Major Western armies have been developing UAV capabilities for a number of years. The Kosovo campaign highlighted the importance of these programs with the U S Deputy Assistant Secretary of Defense for C3 ISR and Space Systems, Rear Admiral Robert Nutwell, stating that “UAVs have made themselves indispensable to the commanders in

this operation (Kosovo), and we cannot contemplate combat or other military operations without them" (Janes Defense Weekly Volume 32, Issue 26, 30 Jun 1999, 10).

UAVs were able to provide visual identification of targets, which enabled the rules of engagement to be met, and provided visual imagery for air strike packages. UAVs were able to designate targets, facilitating the conduct of air strikes. (Janes Defense Weekly, Volume 31, Issue 18, 26 May 1999, 5). Countries within the Asia-Pacific region with mature UAV programs include Singapore, China, India and Pakistan.

The trends that have emerged over a number of years and have been reinforced by the recent Bosnia and Kosovo actions indicate that UAVs will need to consist of a tiered capability. This means it will be necessary to acquire multicapable UAVs to provide the full spectrum of capability, as well as a number of different UAVs to fill the capability deficiency. With UAVs, one size will not meet all requirements. Tactical UAVs with a loiter time of four to six hours and a range of up to 100 kilometers will provide low-level commanders vital information. Operational level UAVs with the ability to loiter for 18 to 24 hours and a larger payload with sophisticated electo-optical sensors and a range greater than 100 kilometers will significantly enhance the targeting capability of joint task forces and brigade level headquarters. Having these systems linked into the decision support systems will greatly enhance the decision making process and provide information to commanders at a much faster rate.

UAVs will increase the complexity of airspace control and, therefore, rely on some form of centralized control in order to provide airspace de-confliction. UAVs will increasingly be used in peacekeeping operations not only for targeting but also for verification and monitoring tasks, as well as force protection. (Janes Defense Weekly,

Volume 32, Issue 5, 4 August 1999, p 28). They will enable forces to stand off and designate targets for either indirect or aerial engagement. UAVs equipped with laser designators will increase in quantity and challenge the traditional employment of ground observation parties, such as the Joint Observation Support Teams (JOSTs). (Janes Defense Weekly, Volume 31, Issue 18, 26 May 99, 5).

UAV systems have traditionally been employed as part of a fire support system. This is expected to continue into the future, although fire support units employing UAVs will become much more multiroled and will need to have electronic connectivity to ensure they can provide services throughout all levels of the battlespace. The study conducted by Michelle Yeamen, "*Virtual Airpower: A Case for Complementing ADF Air Operations with Uninhabited Aerial Vehicles*", explores various options for the ADF and the use of UAVs. UAVs will be used increasingly throughout the entire spectrum of conflict, with their capabilities continually increasing. For example, the Global Hawk UAV, currently being evaluated in a joint arrangement between the DSTO and the US military, is capable of launching from Darwin, flying to Cambodia, and returning, with 20 hours on task. (Yeamen, 1998, 156) Potential future roles for UAVs include support to UN activities in peace support operations, defense force aid to the civilian community, illegal fishing and immigration monitoring and regional engagement. These varied tasks increase the requirement for a multi-tiered UAV capability.

The ADF's current project JP 129 seeks to acquire airborne surveillance systems for focal and wide areas. A range of aircraft with a combination of senses, such as electro-optic and infrared and synthetic aperture radar, is under consideration. Phase 1 of this project, which consists of a trial to refine the concept of operations for this capability,

has a year of decision of 1998/99. Phase 2 of this project, which seeks to acquire airborne broad area surveillance capability for the land forces, has a year-of-decision of 2003/2004 (Defense New Major Capital Equipment Proposals 1998-2003, 34).

Surveillance and Target Acquisition Sensors.

The past few years has seen the maturing of two European TA radars, the enhancement to the US Firefinder Q36 radars and the announcement of further enhancement to the long range Firefinder TA radar's AN/TPQ 37. The area of acoustics, especially as stealth technology continues to grow in popularity, continues to improve as well.

With an increase in artillery ranges and movement for the 155-millimeter systems to become 52 caliber in length, target acquisition systems must be modified or enhanced to locate these systems. The British counterbattery radar (COBRA) requirement was conceived in the late 1980s and as such has a range of 45 kilometers. It is due to enter service with the British Army in 2001 (Janes *International Defense Review* August 1999, 8). There are already plans to upgrade the system to permit it to acquire long range tubed and rocket artillery. The radar will increase its range out to 60 to 100 kilometers. (Janes International Defense Review August 1999, 8).

The US Army's Firefinder radars, consisting of the AN/TPQ 36 and the AN/TPQ 37, are both being upgraded. These radars are designed to be complimentary, with the AN/TPQ 36 detecting shorter range mortarsd tubed and rocket artillery out to 15km and 24 km respectively, whilst the AN/TPQ 37 would acquire longer ranged rocket and tubed artillery fire, out to 30 kilometers and 45 kilometers respectively. Once again with the

improvement in ammunition systems, theses systems must be reviewed to ensure they will be capable of acquiring systems at increasingly longer ranges.

The US Army has recently upgraded its fleet of AN/TPQ 36 radars to a "Version 8" standard, improving the system's detection ability and ranges. The AN/TPQ 36 was designed to detect mortars and guns out to 15 kilometers and rocket systems out to 24 kilometers. With most modern ammunition systems capable of achieving greater ranges than 15 kilometers, the requirement was to upgrade the target acquisition systems. The Version 8 AN/TPQ 36 systems are now able to acquire targets to approximately 20 km and rocket systems to approximately 30 kilometers.

The US AN/TPQ 37 is currently being upgraded and will be redesignated the AN/TPQ 47. This system is expected to be in service by 2004. This US system will have a higher degree of tactical mobility and significantly improves the electronic components for survivability. The AN/TPQ 47 has twice the performance of the older AN/TPQ 37, detecting 155-millimeter artillery projectiles out to 60 kilometers, and tactical ballistic missiles out to 300 kilometers, with a 25 percent improvement in fire unit location accuracy. (Janes International Defense Review December 1998, 5) The AN/TPQ 36 is currently employed within the region by Pakistan, Singapore and Thailand. The AN/TPQ 37 is employed within the region by Singapore and Thailand.

The British Army is also adopting a tiered approach to target acquisition radars. It will be seeking target acquisition radar to support light forces with a range of twenty five to thirty kilometers. These radars will support the British commando brigade and air assault brigade. (Janes International Defense Review August 1999, 8)

Outside Australia, acoustic detection systems have also maintained pace with technology. The British Army advanced sound ranging project (ASP) is due to enter service in 2001, most likely with the British HALO system. The HALO system will cue the active COBRA radar and shorter range radars from the commando and air assault brigades.

The ADF has recently signed a contract for 61 AMSTAR ground surveillance radars to replace the in-service RASIT 3190B. These new GSRs will fulfill the requirement for an all-weather, day/night target detection and classification out to a maximum range of 35 kilometers. The GSR will also provide target acquisition and fire adjustment capability. (Janes Defense Weekly 1 Sept. 1999, 15)

The trends which are emerging for target acquisition radars and sensors include the requirement to acquire 52-caliber weapons systems with a range greater than or equal to 40 kilometers. A tiered target acquisition system will be required, with a lighter and more tactically mobile version to acquire mortars and light artillery, and a larger more robust target acquisition system to acquire the long range tubed and rocket artillery. Tactical ballistic missiles will increase in significance over the next 20 years within the Asia-Pacific region, with countries such as Vietnam, Pakistan, North Korea and India already possessing some form of long-range missile systems. Multiple sensor systems, both active and passive, will be needed in the future to detect the complete spectrum of indirect threats. Longer-range acquisition systems will be highly valuable to the commander and will need to the cued by smaller, less expensive and highly mobile systems. The ADF will have to increase the level of target acquisition coverage to

provide the capability of supporting peacekeeping operations, as well as provide a credible capability during coalition operations.

Space-based systems and aerial platforms will enhance the ability to provide a STA capability. The development of space based systems will be very expensive for the ADF. As described in Chapter 6, the ability to be interoperable with ABCA countries will allow the ADF to access the tactical space bases likely to be employed in the future battlespace.

Joint Offensive Support Teams

The trends for visual, electroptical and electronic observation of the battlefield continues to be in the area of combined sensor platforms for target acquisition. Systems will be linked directly into the sensor-actor network, reducing the time required for target acquisition and increasing the range in which observation can take place. Examples include the US Bradley Fire Support Team Vehicle (B-FISTV), the UK Warrior Observation Platform Vehicle (OPV), and the Canadian LAV-Reconnaissance vehicle.[6]

Under Phase 1B of Project NINOX (Land 53), 33 GSRs will be procured to equip surveillance units in Northern Australia and provide two GSRs per regular artillery regiment.[7] Twenty-eight GSRs will be fitted to ASLAV-S (Surveillance) vehicles, mainly in the 2nd Cavalry Regiment, as well as other cavalry squadrons (Janes Defense Weekly, Volume 32, Issue 9, 1 September 1999, 15). This capability will only provide the ADF with a radar ground surveillance capability. The systems will not be able to designate targets for precision munitions and will still require manual target processing methods due to the absence of an automated digital link with BCSS.

The vehicle provided for Phase 1B of NINOX will equip motorized and light brigades with a wheeled land rover surveillance vehicle, and the mechanized brigade with an M113 armoured personnel carrier. The only systems, however, to have a mast mounted GSR will be the ASLAV-S equipped cavalry units, which traditionally have no JOSTs allocated. This paucity of JOSTs is a reflection of the lack of structural development that has occurred in the RAA since the 1950s. Each medium regiment is equipped with only two JOSTs on the assumption that medium artillery would always be in a general supporting role, with the 105-millimeter field artillery forward providing intimate close support, each with four JOSTs per direct support battalion. This was also based upon the assumption of the linear battlefield, whereby the cavalry operations would be out of range of conventional medium artillery and would be reliant upon offensive aerial support and aerial fire support. Therefore, the two JOSTs allocated to the cavalry operation would be a "facilitator of aerial fire support and would not expect indirect artillery support." (Manual of Land Warfare, 2:1:1, 1995, Part Three, Chapter 11, 11.777)

Whilst the NINOX project will provide the RAA a much needed boost to JOST surveillance and target acquisition capability, the integration of the complete sensor package is incomplete. The RAA has not been proactive enough in its pursuit of a dedicated JOST sensor system vehicle to effectively provide precise fires for the future. This is an example of the industrial based army philosophy, whereby the predominant mode of transport is by foot, and predominately infantry based. The lack of precision munitions in the ADF inventory is reflected in the lack of acquisition systems employed by observers. If the RAA is going to be able to support the AAN, the ability to acquire

targets at longer ranges, continuously and in all weather conditions, whilst providing dedicated observation support to the combat units, will require an integrated JOST vehicle (JOST-V). Having a dismounted GSR, due to be employed by 1st Field Regiment in support of motorized operations, shows a poor appreciation for a capability-based army.

Supporters

Meteorology

One of the most significant impacts on the delivery of Met systems around the world has been the closure of the OMEGA ground based very low frequency tracking stations. The result has been that most military meteorological tracking stations have changed to a GPS based system, incorporating differential GPS for relative position data. The ADF upgraded its MARWIN MW12 systems to GPS in December 1998, three months after the OMEGA stations closed in the Southern Hemisphere. The result was a three-month capability deficiency for the RAA during the middle of one of the largest Army 21 evaluation exercises. [8] The removal from service of the only nonelectronic back-up system to the MARWIN MW12 in June 1996 resulted in the RAA's inability to provide meteorological coverage for three months. This is another example of the RAA implementing the oversight of the RAA capability through a piecemeal and equipment-centric process. An analysis of the entire capability would have indicated the importance of the systems to the overall capability.

The trend that are emerging for meteorological systems is that they will be GPS based, but their application of meteorological information will be used increasingly outside of the fire support community. Currently all three ADF services use some form

of meteorological system. All systems are compatible with Army meteorological systems, often supplementing the civilian Bureau of Meteorology information in remote parts of Australia.

During US Operation JOINT GUARD, artillery meteorological data were relayed to the US Air Force Expeditionary Weather Squadron. One of the reasons for sharing such information was the US Air Force was experiencing some difficulties with collecting local meteorological data. The element was able to share information with the weather squadron because it was co-located at the division headquarters. In addition, artillery meteorological data have direct application to the Air Force weather database. (Operation JOINT GUARD Initial Impressions Report (IIR), Center for Army Lessons Learnt, 1999.) This same situation occurs on a regular basis with the meteorological capability in the Australian Army, with its meteorological information often used to enhance the Australian Bureau of Meteorology's information for remote areas of Australia. Meteorological information is also vitally important for defense force aid to the civil community, that is, during flooding and cyclones, as well as humanitarian aid and peace support operations.

As technology increases, more systems will be reliant upon meteorological information: UAVs, electro-optical sensors used for surveillance and target acquisition by observers, target acquisition and ground surveillance radars, acoustic sensors, aerial fire support and long range anti-tank missiles all rely on good meteorological conditions for peak performance. Future meteorological systems employed by the ADF will incorporate ground, air and space-borne systems. They will not just supply meteorological data to the gun line, but will also be an integral part of the overall meteorological network used

throughout the battlespace. Artillery commanders calling for meteorological systems to be placed at the battery level will need to reevaluate the application of these assets, and call for the meteorological information concerning the effect to be available; where the system resides is not relevant.

Current moves by the Combined Arms Training and Development Center in Puckapunyal, Victoria, to reduce the size of the artillery meteorology trade and embed this system at the subunit level indicate a poor appreciation of the potential for the Army's only meteorological capability (CATDC Minute 6675/4/4, April 99). Again, this provides an example of the platform-centric development process that continues to occur. The RAA lacks a coherent strategy for development as a complete capability, consisting of a system of systems, and providing an enhanced capability to the AAN. What has worked for the ADF and the RAA since World War Two until the present day will not work in the lead up to the AAN.

Survey

The RAA presently has a project proposed under the Minor Capability Statement Land 42.15 to replace the obsolete GAK-1 North Seeking Gyro with either a GPS or inertial based orientation systems. The project, the artillery orientating systems (AOS), has an expected contract date of 2001/2002 (Defense Forward Procurement Plans for Minor Capital Equipment 1999-2004, June 1999,10).

Positional information in the future will become increasingly reliant upon GPS information; however, relying so heavily upon an external source, such as the GPS satellites, can have risks. A 23 November 1998 *New York Times* article regarding civilian use of GPS for commercial aircraft highlighted that the RAND corporation had

conducted an investigation into the possibility of an adversary using battery powered GPS jammers to cause disruption to not only civil aircraft, but also military equipment. A Russian company has already developed a handheld GPS jammer with an advertised range of 150 miles, and the US Department of Defense beliefs that China will be able to completely interdict GPS signals within ten years. (US News, November 8, 1999, 36) This concern is real enough for the US military to conduct a research and development study through the Defense Advanced Research Projects Agency (DARPA) into the use of UAVs as airborne pseudolites to provide a localized GPS signal to ground forces at a much higher power than that of the GPS satellites. This will "fight off the effects of jamming on the DoD receivers." (DARPA, Special Project Office, 19 December, 1999)

The emerging trend for survey is that precise positioning is required at each platform. The traditional notion of survey is, however, also expanding. Delivery systems will become one of many systems, such as TA radars, NINOX equipment and observer systems, that need precise positional and azimuth information. Reliance solely on GPS may present a significant vulnerability in the advanced electronic battlefield of the future. GPS was the ideal and cheap alternative to costly land survey in the 1980s and early 1990s. The RAA removed personnel from units in expectation of the GPS revolution. Once again, however, a platform-centric viewpoint resulted in the removal of capabilities across the RAA prior to adequate systems being put in place. No artillery GPS systems are due to be placed into service until 2000-2001. (Defense Forward Procurement Plans for Minor Capital Equipment 1999-2004, June 1999, 10) With the significant threat to GPS when used against a sophisticated enemy, the future for survey will be a combination GPS and inertial systems integrated at the platform level.

Conclusion

There is no doubt that the current indirect firepower capability is a victim of its history and the equipment specific development and replacement process of the past. The future indirect firepower capability must overcome these issues if the ADF is to have a truly capability based Army.

These liabilities aside, the present capability is well positioned to be able to harness some of the emerging technology to help bridge the capability gap between the AIB and AAN. Some of these areas include the investigation into the acquisition of a dedicated observation vehicle for JOSTs and the complete introduction of the BCSS systems down to the platform level. This enhancement in the deciders and sensors is presently lacking and must be addressed during the ECF. Current decider to actor links must be improved to rapidly improve reaction time and information flow. JOSTs with integral STA and designation systems in vehicles commensurate with their supported unit will significantly enhance the capability and provide the framework for the support to the AAN.

It is necessary to review ammunition and delivery requirements to define both effects and delivery systems requirements for the AAN. A simple equipment replacement of the present M198 and L119, without consideration of the other systems, will perpetuate the Industrial Age indirect firepower capability present in the RAA.

In order to support the ECF and inform doctrine development and the training system, the purchase of improved munitions such as the XM982 or the South African VLAP projectile is needed. Combined with the inclusion of an enhanced BCSS program down to the platform level, the upgrading or replacement of critical sensor systems and

an integrated observation vehicle will provide the ADF a significant capability enhancement, whilst maintaining maximum use of existing legacy systems.

---

[1]The term Combat power trilogy is used to refer to the three elements of combat power, "Firepower, Maneuver and Morale."

[2]Presentation by Fort Sill Project Manager on US Crusader, 21 October 1999 at Fort Leavenworth, Kansas, USA.

[3]Chinese WM-80 273-millimeter rocket systems has a range in excess of 80 kms. Russian SMERCH 300-millimeter system has a range of 70km. Brazil SS-30, range 30km, SS-40 range 40km, SS-60 range 60km, SS-90 range 90km. US MLRS range 32km (Janes Ammunition Handbook, 1998/99 p566, p568, p555, p562 respectively) The US ER MLRS is expected to achieve a range of 39km with a reduce warhead.

[4]China is the only country in the Asia-Pacific region to have rocket artillery with a range greater than 30km.

[5]The initial Brigade is the present US Army force structure trial for the development of a fully wheeled Brigade increasing strategic mobility whilst retaining a high degree of tactical mobility. The fire support for this Brigade is a combination of 120 millimeter Mortars, 155 millimeter Cannon and HIMARS rocket systems.

[6]For detailed information about theses vehicle and systems see Christopher F. Foss, *Janes Defense Weekly,* Issue 31, Volume 9, 3 March 1999, p 37 and Mark Hewish, Janes *International Defense Review*, September 1999, p 76.

[7]Ninox BOP dated 20 Jul 1999.

[8]Due to the late signing of the contract by the ADF, based upon the disbelief that the OMEGA systems would be closed down, the supply of the GPS upgrade for the MARWIN MW12 systems was delayed until late December 1998.

CHAPTER 6

A COMPARISON OF US ARMY FORCE XXI, BRITISH ARMY 2000 AND AUSTRALIA'S FUTURE LAND WARFARE 2030

This chapter will discuss the importance of interoperability as the ADF continues along this journey towards 2030. The American British Canadian Australia (ABCA) standardization agreement will be used to set the level which the ADF and the future indirect firepower capability should seek to achieve to meet AAN requirements. This will ensure that the ADF is able to offer a credible capability in support of coalition operations.

Force XXI is a total reorganization of the US Army in anticipation of the fundamental changes the Information Age will require. The US Army believes that the application of Information Age technologies will result in an "order of magnitude" change in the way which it conducts warfare (Anderson 1997, 166). There are some fundamental similarities between the Force XXI concept for the US Army and the ADF's FLW 2030 concepts.

US Army Force XXI and FLW 2030

The US Army Force XXI is designed to be capable of "simultaneously dealing with agrarian and Industrial Age competitors as well as Information Age adversaries" (Anderson, 1997, 168). An example of this was the intervention in Somalia, where the clansman used rocket propelled grenades to shoot down helicopters and conversely used Information Age systems, such as cellular phones, to communicate. The US Army Force XXI emphasizes structures which are modular, expandable, and rapidly tailorable. The

tailorable and more modular force structures proposed in Army XXI will be enhanced by information technology that should make organizations less rigidly hierarchical. (Anderson 1997, 168).

One of the central themes of the US Army Force XXI is information dominance. It believes that "soldiers using shared and accurate information will be able to have a common picture of the battlespace, and thus facilitate a commander's ability to apply his will to influence the battlespace and dominate it . . . Information operations and information dominance will allow greater synchronization of effort and allow the commander to control the tempo of operations" (Anderson 1997, 169). Information dominance will be achieved by linking sensors at the tactical, operational, and strategic levels of war. "Increased levels of connectivity will provide seamless, continuous and secure communications to allow forces to perform more technical support functions, reducing the number of support personnel in theater, increasing the sensor to actor ratio in theater and reducing the amount of logistics stockpile from the support place in the continental USA" (Anderson 1997, 169).

What is important to note with the US Army's Force XXI is that previously the US military focused on five major equipment systems known as the "Big 5": the UH-60 (Blackhawk), the M1 Abrams tank, M2 Bradley fighting vehicle, AH-64 Apache, and Patriot air defense missile system. The indirect fire system in service during this time was and still is the M109 series 155 millimeter system, progressively upgraded over time, with the current model being the M109A6 Paladin. The requirement to move ahead to the Crusader 155mm system is a result of the requirement to better support the M1A2

Armored Division and maintain a range and precision advantage over any potential adversary.

The focus of US Force XXI has now shifted from an equipment-centric approach to a capability and concept led approach to force modernization. This approach is identical to the one adopted by the ADF in LWD 1 and FLW 2030. The US Force XXI capability approach has determined five modernization objectives: focused logistics, full dimensional protection, information superiority, precision engagement, and dominant maneuver. The other important aspect of the US Force XXI is the synchronization of what FLW 2030 refers to as POSTED. (US Army refers to as Doctrine, Training, Leader Development, Organizations, Material and Soldiers). (Anderson, 1997, 172)

Whilst the US Force XXI and the FLW 2030 concepts are similar, the significant difference is that, although FLW 2030 talks about being a capability led Army, no such capabilities are described in the FLW 2030 document. The result is that the specific capabilities required to meet ADF requirements in line with the three enduring land tasks are open to interpretation, personal influences by commanders, and budgetary limitations. FLW 2030 lays the conceptual framework for the development of future capabilites, but the ADF has yet to define the specific capability requirements at the strategic, operational and tactical levels needed to meet the general concepts outlined in FLW 2030.

British Army 2000 and the ADF Future Fire Support System

The essential difficulty of force development is that it involves planning for an unknown future. Brigadier Pringle, in his article, *British Army (BA) 2000--Towards an Army of the 21st Century,* likens the prediction of the future for armies to that of

describing an elephant without the benefit of ever having seen an elephant. This was taken from experiences by soldiers in the US Civil War, referring to their first combat experience as "seeing the elephant" for the first time, when previously having had the experience of combat only explained to them. The challenge facing the ADF is to determine precisely what the shape and capability our "elephant" will be, and then describing it to commanders who can visualize the future. A large paradigm shift for the ADF will be the move from the Industrial to the Information Age. Another will be the articulation of what capabilities the ADF wants in the future. Presently FLW 2030 describes the concepts without describing the capabilities required.

Before the end of the Cold War, British military planning focussed on the traditional form of conflict between states, anticipating unlimited, high-intensity conflict. The end of the Cold War has given rise to a far more dynamic and uncertain strategic environment in Europe. The peace enforcement, peacekeeping, and humanitarian disaster relief operations in Bosnia, Croatia, Macedonia, and Kosovo are examples of the most recent conflicts in the region and the changing nature of warfare.

The BA 2000 development plan for the twenty first century starts by defining a spectrum of conflict in terms of a "left and right of arc" view of warfare. The aim of BA 2000 is to "describe the capabilities likely to be required by the British Army in the first decade of the next century and describing the doctrinal and structural implications that result" (Pringle 1997, 186).

One end of the spectrum, "View One," envisages the possibility of a major regional conflict or even general war between similarly well equipped, well-trained mechanized forces. This is likely to be expeditionary in nature and carried out as part of

a coalition or alliance. Joint operations will be inevitable, with even closer links between land and air. Units and formations will be smaller but have greater combat power and be highly mobile. With the combination of small forces, increasingly capable sensors and the potential for long-range precision attack, this will further increase the trend towards dispersion on the battlefield. In this "empty battlefield" there will be more room to maneuver, blurring lines between opposing forces. The close range contact battle will be comparatively less important as technology increasingly allows for fighting more remotely and over longer ranges, engaging C3I targets, as well as platforms. However, it will still be necessary to close with the enemy and take and hold ground, demanding ground forces to provide endurance and presence (Dobson, 1997, Issue 13, 1).

The tempo of battle will be high, giving a decisive advantage to the Force that decides and acts more quickly than its opponents. As in the past, forces will be involved in post-conflict activities, such as peace support, humanitarian relief, battlefield clearance, demobilization and restoration of public utilities (Pringle 1997, 186).

> At the other end of the spectrum there is conflict against largely irregular forces. This is characterized by a potential for longer campaigns; by the lack of "rules" (for the irregular forces, at least) and an emphasis on ambush and raids; a critical role for the civilian population; and the occasional inclusion of high technology, either sophisticated devices or widely-available equipment, such as mobile phone technology. Irregular forces may operate with few moral or political constraints; their aims will often be anarchic and unpredictable. They may be associated with criminal groups, drug cartels, religious sects and pressure groups. Their equipment will range from the very basic to the highly sophisticated. Chemical, biological and even nuclear weapons will pose an asymmetrical threat. Civilians and infrastructure, as well as military platforms, will be primary targets. The distinction between soldier and civilian will be blurred, often deliberately. Computer networks, information systems and data banks will also be targets, using easily-accessible technology. In low-intensity warfare, military action will be complemented by that of the

> civil authority (police, security services) and government, as well as that of non-governmental organizations (NGOs)" (Dobson, 1997, Issue 13, 1).

BA 2000 lays the groundwork for a versatile future structure which allows forces to be organized quickly into task-specific units, whether as part of a broader coalition or alliance or acting independently.

<u>Key Deductions from BA 2000</u>

Key deductions from the BA 2000 foundation paper include:

1. Maneuverist doctrine is of paramount importance--the Army cannot afford a war of attrition.

2. The significance of tempo in future conflict places a premium on improved command and control; it is anticipated that this will be met through digitization.

3. There will be increasing pressure to keep up with technology of potential enemies, despite the lack of funding. This will be addressed by periodic "inserts" of state of the art technology into weapons platforms.

4. More flexible use of forces for use in both conventional and low-intensity warfare is needed; this entails increasing the combat power of light forces and the deployability of heavy forces. (Recent deployments to Kosovo, and the Gulf War in 1991 highlighted the vulnerability of the US Army in this area. Hence the recent push by the US Army for a more lighter and deployable brigade sized Force).

5. Future conflicts are likely to be joint and multinational in nature.

6. Junior ranks will bear increased decision-making responsibilities, leading to a higher "quality requirement". The US Army makes strong reference to leader development in the Army Vision 2010, the Force XXI, and JV 2010. Whilst briefly

mentioned in FLW 2030, this is one area which the ADF must address quickly in order to achieve high payoff.

7. Flexible and deployable logistic structures will be required to sustain any envisaged deployment (Dobson, 1997, Issue 13, 1).

Some aspects are common to both low-intensity and conventional warfare:

1. a battlefield that is multidirectional and multidimensional;

2. the need to control the electromagnetic spectrum;

3. closely linked air, land and maritime components;

4. political and social pressure to minimize casualties; increased emphasis on force protection and a maneuverist approach; and

5. increased significance of information warfare. The enemy's command and control assets will be targeted; we need to protect our own command and control (Dobson 1997, 1).

A comparison between BA 2000 and FLW 2030 indicates a remarkable similarity. The ADF prepares to defend Australia against anything from small-scale incursions under the DAA strategy to the more distant possibility of a major attack. Under FLW 2030 this is now described as contributions to coalition operations worldwide (CCOW). At the same time we need to cope with the reality that, for now, it is more likely that forces will be employed in non-defense of Australia tasks: from UN peacekeeping missions to more violent peace operations, such as the Gulf War, and increased regional engagement activities, such as combined exercises with regional defense forces and the US. The most recent and vivid example of this is the present peace enforcement operation in East Timor. All of these activities require a high degree

of interoperability with coalition partners, and, when acting unilaterally, a heavy reliance upon joint operations. These deployments also place a heavy strain on the traditional structure of the ADF, where a more flexible and force packaged structure is required.

Comparison of US Army Force XXI, BA 2000, and FLW 2030

A comparison between the US Army Force XXI, BA 2000, and the ADF's FLW 2030 indicates that there is a need for forces to be modular, highly deployable, integrated with C4ISTAR, interoperable with ABCA countries, and able to deliver precise munitions and integrate all lethal and nonlethal effects through a centralized effect management process. Both the US Army XXI and the BA 2000 highlight that relatively "unsophisticated" forces can acquire weapon systems from COTS suppliers and reduce the time taken to traditionally bring equipment into service. This has the potential to dislocate the ADF procurement, further reducing the slim technological advance the ADF has in the region. Critics of this view will contend that equipment alone does not make a capability. This is a correct statement. However, equipment which can be purchased more readily can be integrated into existing training and doctrinal improvements that over time develop into capabilities. A rigid developmental process based upon capability milestones unrelated to technological improvement and the changing nature of warfare does not provide a responsive system to change, nor allow the preemptive development of doctrine and new training systems.[1]

What is clear from the comparison between the US Army Force XXI and the BA 2000 is the similarities in concept for the future as described in FLW 2030. Therefore, the requirement for interoperability is reinforced by this comparison. A future indirect fire support capability that is truly compatible with ABCA countries would be able to

harness the extensive firepower of large nations such as the US and UK, whilst also being able to offer a credible capability to CCOW. This however is not without cost. The most important capability which the RAA must develop is not delivery systems for interoperability with the ABCA countries, but rather the strategy needed to synchronize all elements of the DESS to ensure interoperability. In order for the RAA to maintain an effective interoperable capability to meet the AAR requirements and support CCOW operations, a strategy is needed to describe how the RAA is going to move from where it presently is in the development process to meet the AAN requirement. Without a coherent strategy considering all aspects of the DESS, the RAA will not be able to effectively support the AAN due to the prohibitive force development process and the requirement for immediate action in the areas of sensor replacement or enhancement.

The future indirect firepower capability must offer other ABCA countries a viable capability. This can be achieved not through some large capital equipment expenditure, but rather through the standardization of critical capability enhances within the DESS. Interoperability will have to be achieved through compatible digital interfaces. This will require that systems such as BCSS are interoperable with US, UK and Canadian digital systems, as well as integral joint systems within the ADF. This will provide the ability to link sensors (human or electronic) to a centralized effects coordination center of any ABCA country to achieve the desired effect. The compatibility of delivery systems is less important, digital communications and effects are the most important. The ABCA standardization program already provides much of the infrastructure for this. The force development process must take interoperability seriously and understand the significant benefits which the ADF can obtain.

[1]An example of where this has occurred is with the Malaysian Airforce. Malaysia purchase a squadron of Mig-29 Aircraft an number of years ago, from Russia, with the payment made in palm oil, due to poor financial conditions in Russia at the time. This aircraft purchase was believed to be an orphan capability and not compatible with the predominately U S equipment purchases in the past. This same aircraft upgraded to the Mig-29N version and armed with the Russian R-77 Air-to Air missile (NATO AA-12 Adder) is claimed to be as good as or even better than the AIM-120A AMRAAM, which the RAAF has yet to purchase. The R-77 missile has a fifteen kilometer range advantage over the RAAF AIM-7F Sparrow, currently used by the RAAF, potentially removing the possibility of the RAAF being able to achieve air superiority in the vital Sea-Air gap. (Asia-Pacific Defense Reporter April/May 2000, 40) Other nations such as Singapore and Thailand are also purchasing superior aircraft and missile capabilities to that of the RAAF in the near future.

CHAPTER 7

THE FUTURE INDIRECT FIREPOWER CAPABILITY REQUIREMENT TO SUPPORT THE AAN 2030

This chapter will discuss the future requirements the RAA will need to consider to support the AAN 2030. It will address issues and concepts raised in the current Strategic Review 1997, as well as the keystone document *Land Warfare Doctrine 1* (LWD 1) and emerging concepts from the Australian document *Future Land Warfare 2030* (FLW 2030). The FLW 2030 document is not doctrine, but equates to the US Joint Vision 2010 document and lays the conceptual framework which the ADF will attempt to attain in the future.

The ADF and the Australian Federal Government are currently working on new strategic guidance to replace the Strategic Review 1997. It is expected to highlight the maturation of the current government policy of a maritime and littoral influence. It is anticipated that the new strategic guidance will be issued in mid-to-late 2000, but will continue along the same general trend as that outlined in the Future Land Warfare 2030. The underlying themes of future conflict are characterized by increasing precision, operations in the littoral environment, and operations in a network-centric warfare environment with the outcome focused upon the effects.

This chapter will also discuss the importance of interoperability as the ADF continues along this journey towards 2030. The American British Canadian Australia (ABCA) standardization agreement will be used to set the level which the ADF and the RAA should seek to achieve to meet the AAN requirements. This will ensure that the RAA is able to offer a credible capability in support of coalition operations.

Chapter 2 laid the foundation of where the RAA is currently in its journey to 2030. It highlighted that the RAA is still heavily influenced by the Industrial Age firepower paradigm of the early twentieth century, with the capability development processes focused on the optimization of available weapon platforms and not effects. This, in turn, has led to a procurement process based on platform replacement that perpetuates outdated concepts and doctrine, and the lack of a 'system of systems' approach to force modernization. The requirement is for the Army to adopt a concept-led and capability-based approach to its modernization, (LWD1 1998, ii) and for the RAA to embrace the notion of effects management. This will enable the effect upon the target, either lethal or non-lethal, to be the outcome, not the means used to deliver or acquire the target. If this approach is taken, the DESS relationship will be synchronized to achieve the desired capability outcome.

Future Threat Environment

The essential nature of warfare is enduring--it is a clash of wills, one side trying to dominate the other through the threat or use of force. Warfare will continue to be characterized by danger, friction, chaos and uncertainty as a result of the combined influences of enemy, weather, climate and terrain. (FLW 2030 2000 Chap 2, 1)

Three threat environments are described in FLW 2030 that will provide guidance to the development of future ADF land capabilities:

1. Low-medium technology massed conventional forces, with the possibility of inserts of high-technology.

2. Low-technology irregular forces, with the possibility of insertions of high-technology, perhaps incorporating asymmetric threats against Australia's national interests and civil society, and

3. High-technology, low mass forces.

These views provide the threat extremes that the ADF must be able to defeat. However, they are not mutually exclusive, and it is likely that future warfare will be an amalgam of all, whereby the adversary seeks to avoid our strengths and exploit our weaknesses (FLW 2030 2000, Chapter 2, 6). In his paper, "Sources and Nature of Future Conflicts in the Asia Pacific Region," written for the ADF publication, *The Future Battlefield*, Malik states that in Asia the probability of a medium-intensity conflict in the foreseeable future is higher than that of a high-intensity or low-intensity conflict. (1997, 82)

Consequently, future warfare has the potential to involve a 'full spectrum' approach, incorporating information attacks, terrorist actions and more conventional physical maneuver. The result must be a shift away from platform-centric capabilities and into more versatile, effects based systems of weapons performance suited to a highly variable and unpredictable future.

"The future battlespace will demand land forces be able to maneuver in the physical dimension, massing effects both temporally and mentally multidimensional maneuver". (FLW 2030 2000, Chapter 2, 8) Operations within the multidimensional battlespace will require an integrated approach that emphasizes network-centric-warfare (NCW) (LWD 1, 1997, 4-15), "within the timeframe of the Enhanced Combat Force,

shifting to Knowledge Centric Warfare (KCW) within the timeframe of the Army After Next". (FLW 2030 2000, Chapter 2, 8)

Network-centric warfare describes the "effective integration of sensor systems, command support systems and weapons systems throughout the battlespace." (LWD1, 1998, 4-15) "Such warfare provides the means for relatively small, high-technology forces to achieve disproportionately greater effects than has been previously possible". (LWD1, 1998, 4-17). "KCW is the application of NCW in a precise manner against critical nodes within an adversary's command and control capability. KCW is thus the exploitation of the knowledge edge through the complete integration of NCW linking information to decisive action. KCW seeks to isolate an adversary's leadership and to fractionate his military capability thus rendering its employment ineffective. This significantly enhances the effects that can be achieved by a small force, and thus has great potential utility for future land forces." (FLW 2030 2000, Chapter 2, 9) This knowledge advantage will lead to enhanced situational awareness that can allow commanders to concentrate effects rather than mass forces. Unfortunately this will result in an increase to the defense budget to pay for theses new capabilities. Peacekeeping operations are manpower intensive, with forces required to be highly visible. No amount of technology can replace the soldier on the ground. Cuts in manpower can no longer be used as an excuse for additional technology and more expensive equipment. This capability enhancement philosophy, based upon the justification of fewer personnel due to improved technological equipment, has maintained the notion of an equipment replacement policy.

Movement from a near total dependence on traditional physical based warfighting practices towards increased emphasis on more soft, or intangible, applications of force requires new operational concepts within the land force. (FLW 2030 2000, Chapter 9, 2) "Situational awareness is the 'knowledge' of the operational environment required to gain the level of understanding necessary to achieve decision superiority, which in turn enables decisive action" (LWD1 1998, 6-12.)

"Success in the multi-dimensional battlespace will require the effective and efficient use of force utilizing new concepts for command, control, and coordination of effort".(FLW2030 2000, Chapter 6, 8) This may result in flattening command structures, with the responsibility to move, position, fire and sustain delivery platforms separated from that of coordinating the effects delivered by the platform. Separate and distinct effects coordination centers (ECC) will be established to better fuse the command decision-sensor-shooter linkages and better support the targeting process. (Colley 1999, 4)

Future Land Warfare Tasks

Strategic Review 1997 identifies three basic tasks which could require the ADF to undertake combat operations: defeating attacks on Australia, defending regional interests, and supporting global interests. (Strategic Review 1997, 29) These tasks have been turned into three main military strategies--Defeating Attacks against Australia (DAA), Defending Regional Interests (DRI) and Defending Global Interests (DGI) – with two additional military strategies – Protection of National Interests (PNI), and Shaping the Strategic Environment (SSI). From these military strategies FLW 2030 has developed three enduring land force tasks. They are:

1. Protection and Security Operations on Australian Territory (PSAT),
2. Archipelagic Operations, and
3. Contribution to Coalition Operations Worldwide (CCOW).

Implementing these tasks will require greater integration of military capability among the Services, increased civil-military integration, and the ability to routinely conduct coalition operations. (FLW 2030 2000, Chapter 3, 3) Future land force employment by the ADF will see an increasing use of information operations in an attempt to maintain a capability advantage over the enemy, known as the knowledge edge (LWD1 1998, 6-11). This knowledge edge will increase the use of precision weapons and non-lethal effects, including cyber warfare, to offset the small size of the ADF. The knowledge edge, as described in LWD 1, relies on exploiting emerging technology, advancement in C4ISR, information operations, decision superiority and sensor-shooter links, to leverage an advantage over an enemy (LWD1 1998, Chapter 6, 11).

Coalition Operations

Experience over the past ten years suggests that the types of operations most likely to involve the ADF will be humanitarian relief operations in places like Africa; services assisted or protected evacuations in Australia's immediate region;[1] peace operations, such as Cambodia and Somalia; or combat operations in support of a United Nations or United States coalition force, such as in the Gulf in 1990-91. This is also supported by the ADF's recent deployment of forces to East Timor. All members of the ABCA countries are represented in the East Timor deployment, for which Australia is the lead nation. The changing nature of Australia's strategic guidance and the emphasis in

the FLW 2030 of the littoral environment may indicate a requirement to increase the formalization of standardization agreements with Asian countries.

All ADF operations in the last ten years have involved operating in a complex environment, underscored by some form of agreement or coalition operations. FLW 2030 postulates that in the time frame of the AAN the United States will remain the pre-eminent military global power, and the one that Australia looks to as its great power security partner. (FLW 2030 2000, Chapter 6, 4)

This US centrality in coalition operations indicates that interoperability between the US and other major allies must be a central theme when determining any future capability. This has the advantage of not only ensuring procedural similarities, but also aiding in logistical support through common usage items.

All enduring land force tasks will involve some level of interoperability, whether joint or coalition. Effective CCOW will require the capacity to achieve high levels of interoperability with an array of coalition partners possessing different equipment and levels of technological sophistication. It also demands different approaches to ADF joint integration. In Archipelagic operations and PSAT the ADF will fight as an integrated force, whereas in CCOW land force elements will operate as part of a coalition land force supported by coalition air and maritime forces. (FLW 2030 2000, Chapter 6, 7) In CCOW, interoperability with allied land forces will become more important than interoperability with RAAF and RAN assets due to the reliance by the land force on coalition assets for support.

The impact on the future fire support capability will mean that we cannot wait until 2030 for this level of interoperability to occur. If Australia is to commit forces for a

CCOW deployment, the ECF will need to adopt similar capabilities to U S forces in the near term. The areas that the ADF will need to watch include any move away from a standard 155 millimetre system, and the ability for U S forces to continue to support electronic components for the AN/TPQ 36, again over the short-term.

Due to the primacy of US forces as a key players in any future coalition operation in which Australia may become involved, it is vitally important that interoperable equipment and procedures exist between the two countries. This standardization of equipment and procedures greatly assists Australia in its ability to harness the much larger capability and forces of the US when operating together. The ABCA standardization program facilitates this commonality of equipment and procedures.

ABCA Standardization Program

The origin of the ABCA Armies' Standardization Program goes back to the close cooperation among the Allies during World War II and is "one of the oldest extant military agreements among any group of nations, tracing its origin to 1947." (ABCA Standardization Program Informational Handbook, 1995, 1.8) The aims of the ABCA Armies' Standardisation Program are to:

1. Ensure the fullest co-operation and collaboration among the ABCA Armies;

2. Achieve the highest possible degree of interoperability among the signatory armies through materiel and non-materiel standardisation; and

3. Obtain the greatest possible economy by the use of combined resources and effort. (ABCA Standardisation Program Informational Handbook, 1995, 1.11)

The program is designed to ensure that Armies achieve agreed levels of standardization necessary for two or more ABCA armies to operate effectively together

within a coalition, primarily in low- and mid-intensity conflict. `Standardization' is defined in the broad sense to cover all action directed towards meeting the aims of the ABCA Armies' Standardization Program. It does not necessarily imply nor require adoption of common or identical materiel or methods (ABCA Standardization Program Informational Handbook, 1995, 1.15).

Aspects of the ABCA agreement are fundamental to the content of most RAA doctrine and shape the way in which procedures develop to ensure interoperability with the member nations. ABCA standardization agreements enhance the capability of the US-Australia alliance and contribute significantly to the successful completion of coalition operations through understanding and interoperability.

The importance of interoperability with the US is highlighted in FLW 2030, which states "in this time frame 1999-2030 it is extremely unlikely that the ADF would be committed to a CCOW warfighting operation that is not United States-led." (Chapter 6, 4) The implication for the ADF is that any contingent provided towards a US led coalition must be worthwhile. Older style capabilities that focus on massing forces and not effects will not be compatible with U S requirements. Whilst equipment may be similar in nature, the present RAA capability lacks digitization and the appropriate electronic command and control systems, as well as an emphasis on effects. This will reduce the ADF's capability to provide a worthwhile contribution to coalition operations.

A comparison among ABCA countries delivery systems indicates that all ABCA countries except Australia are equipped with self propelled systems.[2] By their very nature self-propelled systems are more mobile and able to support a more dispersed battlefield. This is not to suggest that the ADF must purchase self-propelled systems, but

the capability which the ADF offers during a CCOW operations must be able to value-add to the contribution and not inhibit the employment of the RAA or the ABCA coalition contributing nations. With a LOT of 2010 for the current fleet of towed systems, the ADF will be able to support operations only with ABCA marines or light forces equipped with similar forces. Future artillery delivery requirements to support the AAN must consider how the systems will be employed in CCOW and with which other countries, most likely ABCA countries, the delivery systems will need to operate. Whatever complete system the ADF decides to introduce, taking into account the entire spectrum of DESS systems, the future indirect firepower capability will need to have similar tactical, operational and strategic mobility to the likely CCOW contributing nations, as well as compatible C4ISTAR systems.

The ADF's purchase of the battlefield command support system should rectify the present deficiency in digitization. Unfortunately this digitization will not be provided down to the platform level; therefore, the ability to use the system as intended in a network-centric warfare environment will be limited. Also, without the follow-on capability of precision munitions, integrated and enhanced ISTAR, and integrated positioning and meteorological systems, as well as the necessary changes in doctrine, the ADF's contribution to coalition operations will remain in doubt.

Characteristics to Support Future Land Manoeuvre.

With the changing nature of the battlefield and the requirement to move from an Industrial Age force to an information dominant force, certain characteristics will prevail. FLW 2030 discusses these characteristics in detail, but the important ones for the future indirect fires capability are summarized below.[3]

Force Packaging.

The future battlefield will not just include combined arms, but will be force packaged into combined arms teams (CAT). These forces "will underpin future land manoeuvre...forces will be tailored to their mission...enabling the force to be adaptable, versatile and highly capable." (FLW 2030 2000, Chapter 7, 2) The ability to tailor land forces also negates the requirement to develop niche capabilities in order to provide a positive contribution to coalition operations. The size of the force will be scaled to the level necessary to achieve the mission, masking the weakness of one system with the capability of another, creating a dilemma for the adversary (FLW 2030 2000, Chapter 7, 2).

To achieve the tailored force requirement, "land forces will require a modular structure in order to integrate easily into the CAT" (FLW 2030 2000, Chapter 7, 2). This may force the RAA to deploy battery-sized elements within battalion-sized fire support task forces incorporating all elements of DESS into the one unit. For example, fire support units in the future may consist of a combination of different types of delivery systems, such as 105 millimeter, 120 millimeter, 155 millimeter systems. Integral surveillance and target acquisition assets, such as weapon locating and ground surveillance radars, and support systems such as GPS survey and meteorological equipment may also be in these units. Rocket systems may also be included to conduct strike operations in depth. The traditional regimental structure must become more flexible and not limit the commander's flexibility in such a small defense force with limited assets.

Maneuver to Fire

At the tactical level, combat forces will employ both inhabited and uninhabited air and ground combat vehicles to deliver combat power to decisive points in time and space. Maneuver will always be synchronized with predominantly precision effects to disrupt, suppress and destroy adversary capabilities. Maritime operations in the littoral environment will require ground forces to have tactical maneuver coordinated over air, sea and ground. (FLW 2030 2000, Chapter 7, 3) The result will see the transition from "fire to maneuver" to a "maneuver to fire" philosophy, maximizing the abilities of precision stand off systems with tailored effects. The impact here will be that the RAA will need to review its ammunition types and precision systems, as well as increase its ability to deliver ammunition in a precise manner. Systems such as UAVs will greatly enhance the ability to maneuver to fire, ensuring that friendly forces remain disengaged for as long as possible, and only closing with the enemy once the enemy can be defeated. The incorporation of tactical UAVs directly into the sensor-actor[4] network will afford the ADF a high payoff in the area of acquisition and effects management. Improved ammunition systems and the range of adversary delivery systems will increase the requirement for a robust target acquisition system. Sensor to actor networks will need enhancement to ensure that enemy systems cannot range or disrupt friendly forces, reducing casualties and political discontent. Any sensor-actor network that the ADF introduces, such as the emerging BCSS capability, must reduce the time currently taken between target acquisition and effects termination. If a system fails to achieve this, then

the system is no more capable than the existing manual methods. The RAA cannot afford to wait until 2010 to address this issue of precision.

Network-Centricity

The real or near-real time links possible through network-centric-warfare (NCW) will compress the time frame for the sensor-decision-actor cycle to the point where adversary concentrations above a certain threshold will be engaged. Future land forces will be linked to other land forces and ADF and coalition sensor and actor assets so that effects are concentrated rather than forces (FLW 2030 2000, Chapter 7, 3). It could also be argued that, with continuing improvements in precision, even effects will not have to be massed, with a one-shot one-effect capability emerging. These capabilities currently exist in varying degrees with cruise missiles and potentially the 155 millimeter XM 982 GPS guided systems offering this potential. This continues to highlight the importance of all DESS systems to be able to achieve these effects.

If forces are to be truly interoperable in coalition operations, a situation may arise in the future whereby the US Army acquires a target, the ADF engages the target, the United Kingdom conducts some form of battle damage assessment, and the Canadian Army distributes the after action and assessment report. This would be a fully integrated and interoperable system not only applicable to coalition operations, but also able to be used on a stand-alone basis. The advantage for the ADF is that it will be able to harness the firepower of a much larger force, such as the US or UK Army, without owning the capacity itself. However, the ADF must offer a unique capability, otherwise it runs the risk of becoming irrelevant. This highlights the importance of existing standardization

programs, such as the ABCA program, and the importance for future battlefield C4I systems to be interoperable with coalition partners.

Signature Reduction

The transparency of the future battlespace through improved land, air and space based surveillance systems, coupled with increased weapon range and lethality, will enable protagonists to punish physical concentration. Command and control (C2), combat service support (CSS), combat support (CS) and combat elements that are detected will be destroyed. Force austerity to reduce the number and size of targets, signature reduction of individual platforms and installations, and decoying and deception of surveillance assets will all be fundamental to survival and operational viability. A far greater degree of land force dispersion will be required to ensure survival.

The ability to move in the battlespace and remain untargeted will be essential to survival. Conversely, the ability to locate an enemy's key capabilities and to bring effective response through a deliberate and responsive targeting process will result in immediate military advantage. (Air-Vice Marshal, Brian Weston, reproduced in Malik, 1997, 136) One of the largest impacts for the RAA is dispersion of the gun battery position.[5] Without additional command post personnel, independent survey capability, an integrated meteorological network and digitization, the RAA will be limited to deploying a gun battery as a six-gun delivery system over a relatively small area. Whilst doctrine does exist for split position, this can only be performed for 72 hours before the unit must reconstitute, due to personnel and equipment shortages.

These shortages in personnel and equipment are the result of the historical influence upon the RAA. RAA units are still structured to support a predominately linear battlefield within a rigid command and control structure. The RAA has not fundamentally reviewed the structure of the organizations used to support the changing doctrine that has emerged over the past fifteen years to a more distributed and dispersed battlefield. The RAA will not be able to restructure to meet the style of warfare described in FLW 2030 and, therefore, will not be able to reduce the signature of the capability without digitization at the platform level and employment of more precise effect systems.

Lethal and NonLethal Options

The emergence of the effects coordination center concept, referred to in *Future Land Operations for Fire Support* (Australian Defense Headquarters) and in FLW 2030, provides the framework for where the lethal and nonlethal force can be coordinated. Presently ad hoc arrangements in the targeting coordination cell within joint task force headquarters provides a mechanism for the coordination of lethal and nonlethal forces. The composition and status of this cell varies between headquarters and has varying levels of acceptance throughout the ADF. The formalisation of the effects co-ordination centres will increase the awareness of effects coordination and the requirement for a broad range of options, and not solely "kinetic targeting" offered to the commander.

Interoperability

"All platforms in service will be kept as much as possible in a condition to undertake a broad range of operations in our region without further modification, either in joint operations where the Government expects the ADF to take the lead, or as part of a

coalition force" (Strategic Review 1997, 41). This refers to legacy systems within the ADF, and is not compatible with FLW 2030, which clearly describes a much more complicated environment relying upon improved communications and precision. In the past legacy systems were considered to be adequate for an expected service life of about fifteen years and sometimes much longer. The current expected life of the M198 is between 2010 and 2015, indicating a service life of over thirty years. Whilst this is not uncommon for artillery delivery systems, increasing technology means the sensors, support systems and ammunition systems are often far more capable at the end of the thirty year life of service than the delivery system. As has already been shown in chapter 3, a capability enhancement can be attained not by replacing the M198, but by improvement of deciders, ammunition aspects of the effects system and better sensor systems.

The expectation by the force development process must take into account rapid advances in technology and the expectation that equipment may not last as long in service as economically ideal. The present sensor capability in the RAA will need either upgrading or replacement by 2005, i.e., five to ten years before the M 198 is replaced. It is unrealistic to expect that computing systems can last 30 years in service without significant modifications. The requirement to progressively upgrade and modify systems with the ability to insert high technology enhancements must be carefully managed in the future in order to maintain systems that are interoperable with coalition partners and relevant to the modern battlefield.

Close Combat

Close combat will be an enduring feature of land warfare. With increases in technology and weapon lethality, the conduct of close combat will increase in violence and costs. "Precision stand off weapon systems and effects will increase the areas where future land forces can engage" (FLW 2030 2000, Chapter 7, 3). The challenge for the RAA, is not only to continue to support the close fight, but also to increase the level of precision within the fire support system to ensure the close fight can be supported in the future. Indiscriminate dumb HE munitions employed in increasingly urbanized littoral environments will impose limitations on the current RAA capability and the capability of the ECF.

For the RAA to fully support the future land warfare environment, a change in the way the artillery capability is viewed will be needed. Developments in ammunition see 120 millimeter mortars systems with comparable ranges to light artillery (105 millimeter).[6] Additionally 120 millimeter mortars systems often have the ability for sophisticated payloads to fire precision munitions, which lighter and smaller caliber 105 millimeter systems cannot efficiently deliver. Mortars also have the advantage of employment in complex terrain, such as jungle or urban environments, due to their high angle of fire and descent. If the future of land warfare for the ADF is increased operations in the littoral environment, the future indirect firepower capability must also be employed in such complex terrain.

The future indirect firepower capability must be capable of being force packaged for mission specific tasks. The present capability is only suitable for the narrow threat spectrum of warfighting and presents the ADF with few options. The regimental

structure will need to be more flexible, incorporating complementary systems within the one unit. Delivery specific systems, such as those only with 105 millimeter or 155 millimeter systems available, must give way to multi-optional delivery units. Unit employing 120 millimeter mortars and either 155 millimeter tubed artillery or long range rocket systems will be able to support both the close and deep fight, at range and throughout complex terrain. The incorporation of ISTAR assets at all levels will need to be fully integrated through the network-centric environment to rapidly increase sensor-to-actor response time.

The incorporation of multiple effects within the single unit, linked throughout a network will enable massing of effects and not forces at a decisive point. This empty battlespace will enable the reduction in force signature, enhancing force protection.

Central to harnessing the future indirect firepower capability will be the incorporation of both lethal and non-lethal effects through a centralized effects coordination process. This is far more than just the incorporation of electronic warfare in the firepower planning process. All aspects of information operations need to be fully synchronized with lethal effects. Only through this management of effects will the real benefit of network-centric warfare and precision be realized, enabling the battlespace to be decisively shaped to the commander's intent.

Future Fire Support Systems

There will be an enduring requirement to establish fire supremacy over an adversary, if the ADF is intent on winning the nation's conflicts. This will reduce friendly casualties and restrict the enemy's ability to shape his operations through the removal of his critical capabilities. To achieve this, future land forces will require a suite

of complimentary firepower system capabilities that are wholly integrated through highly developed joint command, control, communications, computers, intelligence, surveillance, reconnaissance, and electronic warfare (C4ISREW) systems (FLW 2030 2000 Chapter 8, 5).

The future battlefield will be characterized by mature C4ISTAR systems, which will reduce the significance of dedicated artillery observers, linked only to the maneuver unit. This is the notion that Toffler refers to as the "demassification" of services in *The Third Wave* (1991). The result will be a reduced dependence on a smaller section of the observer community and a decentralization of the ability for sensors to acquire and affect targets.

With the adoption of an effects based organization and the formation of enhanced ECCs (far more efficient than the present JOSCC at the battalion and brigade levels), the distinction between the direct and indirect fire systems will become less clear-cut. Whilst the direct and indirect equipment will continue to remain separate, the target effect delivered by direct or indirect systems will become transparent. An increased quantity of sensors on the battlefield and the employment of NCW will allow the concept that "everyone is a sensor" to be achieved, receiving the effects according to their needs.

FLW 2030 indicates that the future land warfare fire support system must have the ability to mass effects, rather than simply massing maneuver forces. Massing of effects seeks to decisively overmatch the enemy while allowing friendly forces to remain dispersed in order to avoid mass destruction. Increasingly this will be achieved with sustainable precision. Therefore, the demand for high rates of fire and weights of dumb bursting munitions will be dramatically reduced (FLW 2030 2000 Chapter 8, 7). This will

have a profound impact on the sustainability of the future fire support systems, reducing the amount of ammunition which the capability will use. This will enhance the logistical viability of the future fire support capability, enabling a more deployable capability in support of peace support or peacekeeping operations. Caution must be exercised, in that precision systems are more expensive than "dumb" HE munitions. A comparative equilibrium must be found between the quantity of precision systems and the enduring need for large quantities of accurate and efficient suppressing fire to support the close fight in CCOW operations. One area that does need to be addressed is whether the RAA can continue to support the AIB and ECF with the present ammunition and fuse combination. More importantly, the RAA must recommend to the ADF what ammunition systems it will use to support the AAN and at what point this transition commences. The development of a capability to use precision and improved munitions will take years to fully develop.

Ammunition developments continue to improve range, payload and lethality. A substantial capability improvement can be achieved by using older delivery systems with newer ammunition. The M198 is capable of firing almost all modern 155 millimeter ammunition systems, since 155 millimeter is the standard caliber of most Western and NATO countries. Future munitions development will continue to improve capabilities in the area of range and precision, but other areas, such as the ability to discriminate targets without users input and the ability to loiter near targets, will also be achieved in the future (FLW2030 2000, Chap 8, 7). Artillery delivered ammunition incorporating Global Positioning System (GPS) guidance packages are becoming available. The US XM 982 is a 155 millimeter munition being developed by the U S military, with a circular error of

probability of 20 meters for each projectile. Germany's Rheinmetall Waffe and Munition is developing a 155 millimeter spin stabilized projectile with a 10 meters circular error of probability and an expected range of 80 kilometers with a 52 caliber barrel.[7] When individual projectiles have the ability to be designated at individual targets, the entire notion of the artillery delivery system capabilities must be re-thought. The requirement for the artillery to be an area weapon is reduced when individual projectiles can be designated against individual targets with a fire and forget capability.

In the past large quantity of ammunition were need to neutralize an area prior to an infantry assault or to prevent an enemy assault into friendly area. Whilst the latter will still benefit from an area effect, the former will able to be conducted with precision onto individual targets. This will dramatically reduce the requirement for large amount of ammunition, and only require a minimal number of delivery systems for the task. Any delivery systems in range, not necessarily from the observer's unit, will be able to achieve the task. The future indirect firepower capability must move away from attritional missions and embrace essential fire support tasks forced upon effects, fully incorporating all elements of DESS into the maneuver commander's concept of operations and mission essential tasks.

Australia's future military operations will increasingly defend our foreign investments and resources, rather than defend against foreign invasions (FLW2030 2000, Chapter 8, 11). Asian economic stability is important for Australia's economic future. This will result in the ADF's increased employment within the littoral environment and, therefore, its involvement in operations in complex terrain. Threats in the urban environment will utilize "off-the-shelf" technology to cause a tactical stalemate or lessen

those capabilities of the ADF in the future (FLW2030 2000, Chapter 8, 10). The potential exists for countries within the Asia-Pacific region, including Australia, to use off-the-shelf equipment, including aviation, to significantly enhance existing capabilities without significant capital investment.

Conclusion

The future threat environment is likely to be characterized by increasing precision, a strategic move into the littoral regions of Australia's strategic environment, away from a purely "fortress Australia" concept of DAA, with operations being conducted in a network-centric environment and a focus towards massing effects, not forces. The threat spectrum has the potential to range from low to medium technology with the capacity for inserts of high technology equipment. In these conditions the importance of reduced signature becomes vital for force protection and survival.

Success in the multidimensional battlespace will be determined by the speed of operations and the ability to respond to changes more quickly than the adversary. This will necessitate flattening the present hierarchical command structures, impacting on the way the RAA presently conducts force packaging. The RAA must become more flexible in the way it structures for operations. The traditional RAA structure of like type units grouped together, overlaid with larger and longer range weapons to support a linear battlefield, is no longer applicable. The RAA will need to review future fire support requirements for the close and deep fight in a nonlinear environment and structure the future RAA capability to meet them. The historical legacy that presently exists often prevents a thorough analysis of force structures. A combination of long range low angle and short range high angle delivery systems, combined with sensors and supporters, will

be needed in individual units to meet future AAN requirements. A force structure based upon historical precedence is only valid if similar situations are expected to occur in the future and the fundamentals that underpinned the historical period used for the review have not changed. It could be argued that technology and precision have changed the fundamentals of warfare which have existed since 1901 and therefore cannot be used accurately to predict the future structure requirements.

Interoperability has increased in importance for the ADF over the past 20 years, and will continue to be so. The ADF will never have sufficient resources for all its needs and, therefore, will always rely on coalitions and allies for assistance in times of need. The RAA can leverage the technology and capability of more modern forces through the maintenance of interoperable and compatible forces and equipment with major allies, as in the ABCA program.

The RAA can increase the capability of present delivery systems through the acquisition of new and emerging ammunition systems. With a relative small outlay, the RAA would be able to use existing legacy delivery systems and enhance their capability in line with ABCA countries. Ammunition systems would need to offer improved accuracy, range and lethality over the present M1 and M107 systems. This improved capability, however, is not without cost. The cost would be the urgent requirement to upgrade or replace current target acquisition systems and review the capability of the supporting systems to enable a complete system within systems approach.

One of the enduring features of future warfare will be the requirement for the conduct of the close fight. In order to do this more effectively and incorporate maneuver warfare more fully, RAA missions such as destroy, neutralize, harass, are no longer

applicable. The RAA must develop essential fire support tasks that reflect the maneuver commander's mission. These essential fire support tasks, based upon the maneuver commander's plan, allow the artillery commander flexibility in planning indirect fire support whilst emphasizing effects. The development of doctrine in this area is required.

---

[1]This is termed Noncombat Evacuations in US Doctrine.

[2]The US is currently equipped with the 155 millimeter M109A6, (upgrading to the 155 millimeter Crusader in 2005-2007), the UK Army is equipped with the 155 millimeter AS 90, and the Canadian Army is equipped with the 155 millimeter M109A4.

[3]For a detailed explanation of the characteristic of the future land maneuver, see FLW 2030, Chapter 7, 1.

[4]The term shooter implies a lethal response, and the intent in effect management is to include all possible effects, both lethal and non-lethal. The term actor is response neutral and does not limit the application of either lethal or non-lethal force.

[5]The gun battery will normally deploy over an area of approximately 120m by 80, when deployed as a six gun battery. The ability to talk between guns has been enhanced through the introduction of the Pintail radio. The Pintail radio has a range of approximately 5km and was designed for use by an infantry patrol for communication within the infantry platoon. The inability to decentralize the ballistic computation process will still require the gun battery to deploy centrally, using voice as the primary means of communicating ballistics date to the guns. Until this can be overcome, the RAA will still rely upon the concentration of delivery systems to delivery the effects.

[6]Some 120 millimeter mortars are able to achieve 13km, further than the current L119 105 millimeter firing the m1 ammunition.

[7]Christopher F. Foss, *Janes Defense Weekly*, 32, no 15, 12 April 2000 :12.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

The intent for this thesis was to indicate whether the present RAA indirect firepower capability is on the correct path to support the AAN. This thesis has purposely concentrated on looking at the RAA capability as a system of systems and not as individual equipment components, as has been done in the past. One of the most important conclusions for this thesis is highlighting the requirement of a coherent strategy for the RAA to enable it to support the AAN. Without such a strategy the present indirect firepower capability will continue to emphasize an equipment replacement policy and fail to grasp the "concept led and capability based" concept as described by LWD1.

RAA ammunition systems for both the 105 millimeter and the 155 millimeter calibers are antiquated and place the ADF at a regional disadvantage. The maintenance of current ammunition systems until the replacement of the delivery systems in 2010-2015 will seriously undermine the ADFs indirect firepower capability to develop doctrine, training, and enhanced capabilities to support the AAN in 2020-2030. Without a strategy to enhance the sensor or effects systems of the RAA capability, the RAA will be no more capable in the enhanced combat force than it is today. This will undermine the ADF's indirect firepower capability capacity to transition to the AAN and embrace maneuver warfare concepts, such as network centrality and effects management.

The ability to support the nonlinear battlefield, presently described by operations in Northern Australia as DAA is seriously undermined by the scarcity of RAA sensors for target acquisition, as well as the paucity of supporter equipment to support widely

dispersed operations. The inability for JOSTs to operate the future NINOX equipment from an integrated and mobile platform, combined with a lack of a dedicated JOST vehicles to support mobile operations, undermines the ability to support the AAN in the types of operations as described in FLW 2030.

The RAA's present state is due to the historical evolution of the capability and the lack of development in ammunition systems since well before the Vietnam War. This, combined with a force development process that has emphasized equipment replacement programs instead of capabilities, also hinders the RAA's ability to move forward in a coherent manner. The most important factor regarding the future indirect firepower capability to support the AAN will be the development of a capability strategy that will incorporate all aspects of DESS, taking into account likely future battlespace requirements. This one factor will determine whether the present indirect firepower capability will be able to migrate to supporting the AAN. Without such a strategy, the present capability will not be able to transition to fully support the AAN.

The adoption of such a strategy will highlight the importance of ammunition systems and effects, as well as the enormous potential network-centric warfare has for the future indirect firepower capability. At the same time, it will recommend a major doctrinal modification to the way the RAA presently approaches the authorization of fire support. It will identify the paucity of sensors and the requirement to not only increase the quantity of sensors in the RAA, but also link all of these sensors to every other sensor in the ADF to dramatically increase the volume of information available to commanders. This strategy will recognize that the present indirect firepower capability is made up of a number of systems within systems, and that a change in one area can have second and

third order changes in another. This strategy will recognize that, with enhancements to ammunition and supporting systems, the present 105 millimeter and 155 millimeter legacy systems are quite capable of staying in service well past 2010. This strategy will recognize that the present target acquisition systems, which are presently obsolete or unable to acquire 73% of regional artillery, will require immediate remedial action. The adoption of such a strategy will determine if the RAA continues to remain relevant throughout the entire spectrum of warfare, from military support operations to warfighting.

The level of interoperability the RAA adopts with the ABCA countries will also heavily influence its ability to support the AAN. Future warfare will require Australia to become involved in coalition operations more frequently. With an interoperable indirect firepower capability significant benefits can be obtained by the ADF. Australia will be able to harness the energy and the Informational Age technology of the other ABCA countries, while still maintaining a capability that is commensurate with strategic guidance, force structure and the defense budget. Additionally the ability for DESS elements to provide information to organizations outside of the RAA must also be developed, such as AN/TPQ 36 providing information directly to close air support, mortar platoons, or reconnaissance patrols, instead of just the present indirect firepower systems. The functionality of a widely adopted network-centric style of warfare with digitized platforms at all levels allows the passage of targeting information from sensors to any number of effects platforms, which traditionally were limited by rigid command structure and communications. Harnessing the enormous potential of the digital network will redefine the way future indirect firepower systems operate. This will require

improvement in doctrine as well as training, with a greater degree of decentralization of assets. Combined with an informed and centralized effects coordination process at various levels, this will greatly improve response speed, improving future capability to add to the AAN in a maneuver warfare environment.

Supporting systems, such as meteorology, are presently capable of linking into civil agencies to provide information to the Royal Australian Air Force, Royal Australian Navy, Army aviation, UAVs, disaster relief operations and the mission planning process. Not providing this capability represents a lack of capability utilization. The supporting elements of the DESS are able to greatly enhance the ability for components of the future indirect firepower capability to provide the commander with capabilities to support non-warfighting missions, such as humanitarian aid and disaster relief. Supporting systems can be deployed independently of the delivery systems to support peace support operations. The failure to deploy these systems independently of delivery systems has been due to the cultural linking of all aspects of the capability to the delivery component. This has prevented the maximum utilization of these assets in the past.

With the increasing quantity of sensors on the battlefield and with the RAA acquiring numerous sensors through the NINOX program, the management of information from these sensors will be a significant challenge for the RAA. The ability to manage sensors, such as JOSTs, now an integral part of the brigade surveillance and information collection plan, will place additional burdens on the Industrial Age coordination of indirect firepower historically adopted by the RAA. The traditional notion of a dedicated observer to the infantry should not cease. However, the inclusion of a multitude of other sensors in this "exclusive club" of indirect fire direction will,

provide a cultural challenge for the RAA. The diversification of sensors and the adoption of network-centric warfare, facilitated in part through BCSS, will force the RAA to investigate the role of the JOSTs, as well as the capacity of the JOSCC to handle this increased information flow.

The ability to adequately control the effects of the future battlespace will also provide a challenge for the RAA. Future indirect firepower systems will need a more robust effects management process based upon Information Age technology, rather than relying on Industrial Age structures and processes that presently exist. An effects management process which fully incorporates all elements of both lethal and nonlethal effects must be implemented. Present structures and processes only pay lip service to this requirement. Present command structures at brigade headquarters and above are not properly trained and their present structures do not allow the full integration of nonlethal effects. Also rigid command and control procedures to implement both planned and non planned fires prevent the full utilization of the advantages of network-centric warfare. The historical development of the RAA inhibits movement into the Information Age without a thorough investigation on how the future firepower capability will support the AAN force. Effects management will be the area to which the future indirect firepower capability will be able to contribute the knowledge edge for the ADF, specifically in the area of the integration of both lethal and nonlethal effects and the incorporation of information operations to planning and response process. This is an area which requires further study.

While history is a guide to the lessons we need to use in the future, history and culture can also limit the ability to prepare for the future. Force packaging of the ADFs

future indirect firepower capability is one area that also requires further study. Historical influences upon the RAA determine the present firepower capability structure and limit the degree to which changes are made. If the RAA is to remain relevant on the future battlefield, not only will the present capability need to offer the commander more flexible response options through both lethal and nonlethal response, but it must also offer a more flexible force composition. History in this case may, however, provide the key to the RAA's future force packaging. A combined high-angle and low-angle weapon system of systems will provide the best option for the RAA to support commanders in complex terrain. The combination of mortars and field artillery in the same unit, electronically linked to sensors and supporting systems, will greatly enhance the present and future indirect firepower capability. Utilizing legacy delivery systems and upgraded target acquisition systems, combined with improved and precise 105 millimeter, 120 millimeter, and 155 millimeter ammunition, the indirect firepower capability for the ECF would be able to engage the entire spectrum of threat targets across all aspects of the terrain profile and lay the foundation for the capability to support the AAN

The RAA is still an Industrial Age capability. The sooner it truly embraces the Information Age, which is more than digitization or computerization, the sooner the present indirect firepower capability will be able to culturally and technologically migrate to the AAN.

The most important factor in the RAA's support to the AAN is to develop a strategy that will embrace all aspects of the DESS within the present indirect firepower capability. The adoption of a system of systems approach by the force development

process and the RAA will ensure that the future indirect firepower capability can support the AAN. The adoption of such a strategy must occur in the short term.

A hurdle which the ADF will need to address is who precisely now is the RAA. With the demise of the heads of corps, the term RAA now refers to a collective group of units linked by heritage and culture. There is no overarching technical body able to champion an effort to overcome these problems. The formation of the Combined Arms Training and Development Center, which was designed to take on these responsibilities, will need to pick up where the heads of corps left off and address these issues.

The following recommendations are made:

1. Develop a strategy for the future indirect firepower capability, linking the requirements to strategic guidance, national military strategies and future land warfare tasks as detailed in necessary guidance, addressing all of those points raised in this thesis.

2. Determine the structure and composition of the future effect coordination centers, incorporating all elements of lethal and nonlethal effects, and migrate existing doctrine and force structures to incorporate such structures in the ECF.

3. Investigate, as part of the overall future firepower capability strategy statement, future target acquisition systems to replace the AN/TNS 10 and the AN/TPQ 36 systems.

4. Purchase improved smart and precise munitions for the use in the M198 and L119 delivery systems for support to the ECF.

5. Incorporate BCSS down to the platform level for all delivery and sensor systems within the present and future firepower capability.

6. Nominate an organization to have the lead on the development of this strategy.

REFERENCES

Anderson III, Edward G., Major General. 1997. "*Force XXI - America's Army of the 21st Century*" In *The Future Battlefield*, p. 166, Commonwealth of Australia.

Australian Defense Force Warfighting College.1998. *Decisive Maneuver Australian Warfighting Concepts to Guide Campaign Planning*. Newcastle, Australia.

Australian Department of Defense. 1997. *Australia's Strategic Policy 1997*, Canberra, Australia.

Australian Department of Defence. 1994. *Defense of Australia 1994*, Canberra, ACT, Australia.

Australian Department of Defence. 1998. *Defense new major capital equipment proposals (Pink Book) 1998-2003,* Canberra, ACT, Australia.

Australian Department of Defence. 1998. *Land Warfare Doctrine 1: The Fundamentals of Land Warfare,* Combined Army Training Center, Puckapunyal, Victoria, Australia.

Australian Department of Defence, 1999. Director General Land Development, Science and Technology Plan 1999, Chapter 6, *Fire Support*, Canberra, Australia.

Australian Department of Defence. 1995. Manual of Land Warfare, Part 2, Volume1, Pamphlet 1, *Employment of Field Artillery*, Government Printing Service, Australia

Australian Department of Defence, 1988, Manual of Land Warfare, Part 2, Volume 1, Pamphlet 2, *Application of Fire Support*, Government Printing Service, Australia

Bailey, J. B. A. 1989. *Field Artillery and Firepower*. Oxford, London: The Military Press.

Bradley, Michael J. 1989. Field Artillery Doctrine: Does it Support Maneuver Warfare? Monograph, School of Advance Military Studies, Fort Leavenworth, Kansas, USA.

Center for Army Lessons Learned. 1999. OPERATION JOINT GUARD BHCAAT XII Initial Impressions Report (IIR). Appendix A, Fort Leavenworth, Kansas.

DARPA, Special Project Office, accessed at htttp://www.darpa.mil/spo/Programs/gpsguidancepackage.htm, 19 December, 1999

Director General Future Land Warfare. [Draft March 2000.] *Future Land Warfare: Land Warfare Concepts 2030,* Department of Defense, Canberra, Australia.

Dobson, Jill. *British Army: Plans For The Next Century.* Directorate of Army Research and Analysis, Issue No 13, March 1997, accessed online at http://www.dod.gov.au/lwsc/issue13.htm#BA2000, 14 January 2000.

Dunn, Michael, December 1996, *Questions for the new Strategic Review*, online at www.dod.gov.au/lwsc/issue11.htm#SR97, accessed 10 Oct 1999.

Evans, Michael. 1999. *Conventional Deterrence in the Australian Strategic Context,* Land Warfare Studies Center Working Paper No. 103, Canberra, Australia.

Foss, Christopher F. 1998-1999, *Janes Armor and Artillery, 19th ed*, London, UK, England, Butler and Tanner Limited.

Fowles, David C. 1996. *Potential into Power: The King of Battle's Transformation into the 21st Century.* Monograph, School of Advance Military Studies, Fort Leavenworth, Kansas.

Gander, Terry J., and Charles O. Cutshaw. 1998-99, *Janes Ammunition Handbook,* 7th ed, London, UK, England, Butler and Tanner Limited.

Horner, D. 1993. *The Army and the Future, Land Forces in Australia and South-East Asia.* Commonwealth of Australia. Canberra.

Malik, Mohan J. 1997. *The Future Battlefield*, Commonwealth of Australia, published by Deakin University Press, Geelong, Victoria, Australia.

McMeen. Scott R. 1991. *Field Artillery Doctrine Development 1917-1945*, MMAS Thesis, Fort Leavenworth Kansas.

Miklos, Michael T. 1996. Field Artillery, The Ascending Branch of Force XXI. Monograph, School of Advance Military Studies, Fort Leavenworth, Kansas.

Paret, Peter. 1986. *Maker of Modern Strategy from Machievelli to the Nuclear Age.* Princeton, New Jersey, Princeton University Press.

Pringle, Andrew. 1997. "BA 2000-Toward an Army of the 21st Century", In *The Future Battlefield.* Edited by J. Mohan Malik. Melbourne: Deakin University Press.

Thummel, Claude. R. 1914. US Field Artillery Journal, Volume IV, No 1, US Field Artillery Association, Washington DC.

United States Army, 1919. A Study of the Armament and Types of Artillery Material to be assigned to a Field Army, US Field Artillery Journal, US Field Artillery Association, Washington DC.

Smith, John. T. 1998. Precision Warfare Enables Interdependent Fires and Maneuver in 2010, Monograph, School of Advance Military Studies, Fort Leavenworth Kansas.

Young, Thomas, S. 1996. Force XXI Field Artillery: King of Battle or Twenty First Century Dinosaur? MMAS Thesis, Fort Leavenworth Kansas.

Weston, Brian. Air-Vice Marshall. 1997. The Future Battlefield: the Joint Application of Force, reproduced in *The Future Battlefield*, p. 136.

INITIAL DISTRIBUTION LIST

1. Combined Arms Research Library
   US Army Command and General Staff College
   250 Gibbon Ave
   Fort Leavenworth, KS, 66027-2314

2. Defense Technical Information Center/OCA
   8725 John J. Kingman Rd., Suite 944
   Fort Belvoir, VA, 22060-6218

3. Director General Force Development (Land)
   Russell Offices
   R1-3-C005
   Department of Defense
   CANBERRA ACT 2600
   Australia

4. Embassy of Australia
   Office of the Military Attache
   1601 Massachusetts Ave NW
   Washington, D.C 20036-2273

5. LTC Charles J. Guerry
   Combined Arms Doctrine Development
   US Army Command and General Staff College
   1 Reynolds Avenue
   Fort Leavenworth, KS, 66027-2314

6. LTC Craig W. Orme, CSC
   Department of Joint and Multinational Operations
   US Army Command and General Staff College
   1 Reynolds Avenue
   Fort Leavenworth, KS, 66027-2314

7. Dr. Harry S. Orenstein
   Combined Arms Doctrine Development
   US Army Command and General Staff College
   1 Reynolds Avenue
   Fort Leavenworth, KS, 66027-2314

CERTIFICATION FOR MMAS DISTRIBUTION STATEMENT

1. Certification Date: 2 June 2000

2. Thesis Author: Major Philip R. Swinsburg, Australian Defense Force.

3. Thesis Title: The Australian Indirect Firepower capability—Bridging the paradigm from Industrial Age to Information Age firepower.

4. Thesis Committee Members Signatures:

LTC Charles J. Guerry

LTC Craig W. Orme

Dr. Harold S. Orenstein

5. Distribution Statement: See distribution statements A-X on reverse, then circle appropriate distribution statement letter code below:

A B C D E F X SEE EXPLANATION OF CODES ON REVERSE

If your thesis does not fit into any of the above categories or is classified, you must coordinate with the classified section at CARL.

6. Justification: Justification is required for any distribution other than described in Distribution Statement A. All or part of a thesis may justify distribution limitation. See limitation justification statements 1-10 on reverse, then list, below, the statement(s) that applies (apply) to your thesis and corresponding chapters/sections and pages. Follow sample format shown below:

EXAMPLE

Limitation Justification Statement	/	Chapter/Section	/	Page(s)
Direct Military Support (10)	/	Chapter 3	/	12
Critical Technology (3)	/	Section 4	/	31
Administrative Operational Use (7)	/	Chapter 2	/	13-32

Fill in limitation justification for your thesis below:

Limitation Justification Statement	/	Chapter/Section	/	Page(s)
	/		/	
	/		/	
	/		/	
	/		/	
	/		/	

7. MMAS Thesis Author's Signature:

STATEMENT A: Approved for public release; distribution is unlimited. (Documents with this statement may be made available or sold to the general public and foreign nationals).

STATEMENT B: Distribution authorized to U.S. Government agencies only (insert reason and date ON REVERSE OF THIS FORM). Currently used reasons for imposing this statement include the following:

1. Foreign Government Information. Protection of foreign information.

2. Proprietary Information. Protection of proprietary information not owned by the U.S. Government.

3. Critical Technology. Protection and control of critical technology including technical data with potential military application.

4. Test and Evaluation. Protection of test and evaluation of commercial production or military hardware.

5. Contractor Performance Evaluation. Protection of information involving contractor performance evaluation.

6. Premature Dissemination. Protection of information involving systems or hardware from premature dissemination.

7. Administrative/Operational Use. Protection of information restricted to official use or for administrative or operational purposes.

8. Software Documentation. Protection of software documentation - release only in accordance with the provisions of DoD Instruction 7930.2.

9. Specific Authority. Protection of information required by a specific authority.

10. Direct Military Support. To protect export-controlled technical data of such military significance that release for purposes other than direct support of DoD-approved activities may jeopardize a U.S. military advantage.

STATEMENT C: Distribution authorized to U.S. Government agencies and their contractors: (REASON AND DATE). Currently most used reasons are 1, 3, 7, 8, and 9 above.

STATEMENT D: Distribution authorized to DoD and U.S. DoD contractors only; (REASON AND DATE). Currently most reasons are 1, 3, 7, 8, and 9 above.

STATEMENT E: Distribution authorized to DoD only; (REASON AND DATE). Currently most used reasons are 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10.

STATEMENT F: Further dissemination only as directed by (controlling DoD office and date), or higher DoD authority. Used when the DoD originator determines that information is subject to special dissemination limitation specified by paragraph 4-505, DoD 5200.1-R.

STATEMENT X: Distribution authorized to U.S. Government agencies and private individuals of enterprises eligible to obtain export-controlled technical data in accordance with DoD Directive 5230.25; (date). Controlling DoD office is (insert).